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THE TELEGRAPHIC JOURNAL AND
ELECTRICAL REVIEW.

VOL. XXV. JULY 19, 1889. No. 608

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## WILL ELECTRICITY SUPPLANT STEAM ON CITY RAILWAYS?

THIS question has been considered by Mr. Leo Daft in a recent paper read before the American Institute of Electrical Engineers. Mr. Daft is one of the pioneers of electric traction in the United States, he has been actively engaged in constructing electric tramways, and he has had in his mind for six years past the problem of working the New York elevated railways by electricity. The idea of substituting electric for steam locomotives appears to us an exceedingly bold one, and we could scarcely suppress a natural bias towards adverse criticism whilst following Mr. Daft's arguments, until we came to a series of figures which seemed to give conclusive evidence on the side of economy. The paper commences with a refutation of the generally accepted coefficients of traction, and the author quotes some experiments which he carried out in the year 1882 with a small motor which was made to propel a model car up an adjustable incline. This car weighed 450 lbs., and with one man on it the total was raised to 600 lbs. The angle of inclination was gradually increased until it was equivalent to a gradient of 54·9 per cent. when the car still managed to mount it, and stopped and started midway in its course. The rolling resistance was estimated at 10 lbs. per ton, giving for the experimental car 2·25 lbs. The resistance due to the inclination was calculated to be 329·4, making a total of 331·65 lbs., or 55·27 per cent. of the entire load, which is considerably more than double the ultimate working limit of adhesion under the most favourable conditions cited by most authorities. Mr. Daft does not pretend to assert that the adhesion in the case of large locomotives may be increased to such an extent; indeed, subsequent experiments showed that the observed effect in this instance was due to a very large current of low potential passing through very small contact areas presented by wheels of only 1 foot in diameter impinging upon a light rail; the effect is, however, undoubtedly obtainable to the extent of 30 per cent. under the ordinary conditions of railroad practice.

Since October last experiments have been made with the locomotive "Ben Franklin" upon a portion of the tracks belonging to the Manhattan railway, and the results were carefully watched by the officials of the railway company. Originally, permission was granted to run only between the hours of 9 p.m. and 4 a.m.; but the performance of the motor was so good, that later on the electric locomotive and train were allowed to run also in the daytime, taking turn with the ordinary trains, which travel at periods of 3 minutes apart. The electric locomotive weighed 10 tons, as against the smallest steam engines of 18 tons each. Trains were made up of 2, 3, 4, and even 8 carriages of 12 tons weight each. On the 12th of February a train of four cars, each with 75 to 100 passengers, and weighing 70 tons, was run over the road between the ordinary steam trains, but the brakes were hardly trustworthy enough for such critical work. In order to measure the speed with accuracy, the electric line was divided into 19 sections of 500 feet, each section being provided with a thin copper plate attached to the guard rail. This made temporary contact with a copper brush attached to the vehicles in such a manner that it could sweep over the guard rail and convey the current to a chronograph. Indicator diagrams were taken at the central station, whilst dynamometer readings were recorded simultaneously.

The mean power exerted at the central station for propulsion during a trip was 103 horse-power, which compared favourably with steam practice. It has been shown "that on the Third Avenue road, with 80 ton trains and 22-ton steam locomotives, 170 horse-power is not infrequently exerted. Hence," says Mr. Daft, "to consider this problem merely by the ordinary coefficients of rolling friction and gravity resistances would, and does frequently lead to very serious errors in computing the amount of power actually used on short railroads with frequent stops." Based on the experience gained so far, Mr. Daft computes a table in which he endeavours to show that for five hours out of 16 of daily service, 3,157 horse-power would be required, including contingencies, but the rest of the time the demand is greatly diminished, and the average results show that the total per day equals 29,940 horse-power hours, which divided by 16, the number of hours of service, gives 1,871 horse-power per hour, and adding 300 H.P. for dynamo and engine friction the total should be 2,171 horse-power. For this 41 tons of fuel, inclusive of banking the fires, will be requisite, which costs 92·25 dollars per day at the rate of 2·25 dollars the ton. An evaporation of 7·5 lbs. of water per lb. of coal is assumed, and a consumption of 2·2 lbs. of coal per horse-power hour. The present steam locomotives on the Ninth Avenue require 40 tons of coal per day of the very best quality, which costs 200 dollars, or more than double that for the electric system, as estimated. To the electric estimate, however, it is necessary to add such charges as wages of firemen and engineers at the central station, which would bring this item to 150 dollars per diem, considering other items balanced; the cost of repairs, depreciation, &c., is estimated to be about equal in the two cases, which, Mr. Daft believes, is not far from the fact, and he summarises in the following words:—"It is thus evident that without considering the future obvious advantages which must necessarily accrue from the use of a great central station equipped with dynamos as before stated, and a conductive system ample for all requirements of the road, that with the comparatively wasteful central station arrangement we have here considered, involving the use of small dynamos of a very old type placed at the extreme end of the conductive system, and suffering from many incidental disadvantages, that it is possible to run the Ninth Avenue Elevated Road with electric motors at an actual and considerable saving of fuel to-day, and if this is not the only example of such a practical demonstration, as opposed to direct steam propulsion, it is at least the first I have been able to find on record."

In view of the great variations in power which necessarily takes place with conductor systems, we are of opinion that Mr. Daft's estimate of 2·2 lbs. of inferior coal per H.P. is very much too low; nevertheless, we wish him every success. If he can prove his figures on the larger scale, as proposed, then he deserves every praise which can be bestowed upon him. The directors of our Underground Railway, which at this time of the year almost suffocates its patrons, may take the above facts to heart and emulate the encouragement given to Mr. Daft by the American railway officials.

THE Anglo-American Brush Electric Light Corporation, Limited, has virtually been beaten on the incandescent lamp patent suit; it has lost the compound winding case; and its directors think that the present moment is a favourable one for the reconstruction of the corporation with the new title of the Brush Electrical Engineering Company, Limited. As an off-set to the above mentioned mishaps it is proposed to saddle the shareholders with "two old men of the sea," in the guise of the Falcon Engine Works and the Australasian Company. Whether this policy is a wise and judicious one remains to be seen, and unfortunately we have not yet heard anything respecting the good or ill fortune of the mammoth combination of a few weeks ago to enable us to speak with certainty as to the ultimate result. We say unfortunately, advisedly, as we believe the principle actor in the one plays the leading rôle in the other.

TURNING for a moment to the business statement of the Brush Corporation it will be seen that the future bears a very rosy hue. To adequately cope with the demand which appears within the Corporation's grasp undoubtedly necessitates an extension of works, and for this purpose the Falcon Works may be eminently fitted. Labour will assuredly be found somewhat cheaper and other conveniences may make it very desirable to secure these premises, but it is to be hoped that the directors of the Brush Corporation will keep strictly within the sphere of their own legitimate trade and not launch out into undertakings formerly carried on in these works with anything but success. Assuming that this will be the case there is nothing to cavil at in the terms under which the amalgamation is projected.

WE think we are right in stating that the Australasian Company originated the compound-winding fight. The company objected to compound-wound dynamos of others manufacturers entering the domain which it controlled under license from the parent company, whose patent rights it had acquired, and we understand that, through the pressure brought to bear upon Father Brush by his antipodean offspring, there resulted the series of actions which culminated in the celebrated Edinburgh decision.

WE quite coincide with the belief of the Brush directorate that the period of depression in the electrical trades is on the wane and if their proposed scheme is rigidly carried out on legitimate business lines, there appears to be no insuperable obstacle to the ultimate payment of dividends. The Anglo-American Brush Corporation has been one of the leading factors in the electrical world since its inception; let us hope that in its altered condition it will still keep equally well to the fore. It is difficult, however, to see who will be the gainer by the proposed amalgamation.

MR. MATTHEW ARNOLD, whose words demand and receive from scholars of all denominations the greatest consideration, insists that conduct "which is three-fourths of life," is shaped more by literature than science, and that, therefore, literature is pre-eminent. Prof. Rowland, on the other hand, urges that no training to which a young man can be subjected is equal to a scientific education for inculcating thorough honesty. When a man knows that correct deductions from his experiments depend upon the absolute accuracy of his description of them; that science would be impossible without confidence in the perfect reliability of its chroniclers; he learns, of necessity, a valuable moral lesson.

WE quote the following from a thoughtful article by George H. Stockbridge in the New York *Electrical Engineer*, entitled "Where shall we place the Engineer?":—"It is significant that the engineer at present is finding a good many eulogists. Sir Frederick Bramwell has done his part. The Scribners are doing theirs by publishing an extended series of articles on railroads and electricity—exceedingly well written articles, too—showing that some of the literary classes are interested, or that some of the engineers excel in two arts. It is true the railroads had acquired an enormous growth and importance before this honour was accorded them, and that the electrical arts should be similarly honoured, tells its own story."

AT the recent meeting in Paris of the Institution of Mechanical Engineers, a paper was read by M. Edouard Delamere-Deboutteville, entitled "Gas engines, with a description of the Simplex engine." Before entering into details of the Simplex engine, an historical account was given of the inventions connected with gas engines from as long back as 1791, when John Barker published his description. Some 700 patents have been taken out since 1860, the date of Lenoir's arrangement, for improvements or inventions connected with prime motors actuated by gas. The author passed rapidly over the most important inventions since 1791; but his knowledge does not appear to have been quite brought up to date, seeing that no mention is made of such machines as the Atkinson, or the Griffin, which figured so prominently at the Society of Arts motor trials; while in regard to the Otto engine, some details are adversely criticised, which have been abandoned by the makers for some considerable time past. The various methods of ignition are reviewed, the author considering that most of the troubles in connection with the successful working of gas engines arise from the difficulty of obtaining a satisfactory means of igniting the charge, and he comes to the conclusion that ignition by the electric spark is the most effectual and certain in its action, and the mode, a continuous stream of sparks, adopted in the Simplex engine, has overcome all the difficulties that occur when dealing with various qualities of gas. The engine is constructed on the four-cycle plan of Beau de Rochas, but possesses many novelties in the details. The slide is simple, merely a cast iron plate with two holes; the air and gas are not mixed in the cylinder, but in a separate receptacle outside, and thence drawn into the cylinder by the motion of the piston. The regulation of speed is controlled by the admission or non-admission of a charge, the governor used being either an air one or of the pendulum species. In engines over 20 H.P., the motor is constructed in the ordinary manner, and the external mixing chamber dispensed with. Some trials of this engine give economical results; in one case, with an effective horse-power of 6·70, the consumption of gas—ordinary town—was 22·09 cubic feet per effective horse-power. A 50 horse-power engine, using Dowson gas, with a load from 35 to 40 electrical horse-power, consumed 51 lbs. of English anthracite in the Dowson generator per hour; *i.e.*, about 1·3 to 1·148 lb. of coal per electrical horse-power hour.

IN the course of the discussion which followed on the succeeding day, Mr. Holroyd Smith took exception to the historical part of the paper, and showed that Messrs. Crossley were not the originators of the system they used, but Beau de Rochas. No description of any modern engine, with the exception of the Otto, was to be found in the paper, and he considered that to use electrical ignition in place of the available natural means, was to take a retrograde path, and make the Simplex into a complex motor. Prof. Kennedy said there were many good engines in the market which might have had a place in the paper, and it would have been interesting and instructive to compare them with the Simplex; he did not concur in the author's strictures on the use of an igniting tube. The system of governing used in the Forward engine is within a range of 20 per cent. by dilution of the charge, and beyond this by "hit or miss." He thought the pendulum governor a very ingenious device. Mr. Scott Moncrieff differed from Mr. Holroyd Smith as to the use of electric ignition. Mr. Kapp remarked that the production of a spark from a dynamo necessitated a high speed, but he had seen in the Exhibition, applied to a gas engine, a dynamo in which the armature was oscillatory, not rotary. The motion was obtained by a spring and trigger, and though the flywheel was travelling slowly, an effective spark was produced by the rapid motion of the armature. It was stated by Mr. Shields that the life of an ignition tube might be safely reckoned at a fortnight or three weeks, not two or three days as had been inferred. M. E. Delamere Deboutteville, in replying, said that he had found the electric spark possess many advantages over the other modes of ignition when using poor gases; the battery he used lasted from 200 to 300 hours without recharging. It had been asked why there was over compression at the end of the stroke. In this engine a part of the stroke was made before the ignition took place. This was that pressure might not be put on the crank pin when the engine was on the dead point. As a certain definite compression was required to get the best effect of the explosion, the mixture had to be over-compressed at the end of the stroke in order to have the required amount of compression when the charge was ignited.

M. DECAUVILLE, the constructor of the railway at the French Exhibition, laid down a line at his works at Petit-Bourg for the accommodation of the American Engineers and the members of the Institution of Mechanical Engineers, during their respective visits. The line ran from the works to his private residence, the Château des Tourelles, where lunch was hospitably provided for his guests. Besides the works and the machinery therein, which is of the latest and most improved type, he showed his visitors some locomotives for tramways, and made some experimental runs with an electric locomotive driven by storage batteries.

IT is gratifying to hear from all sides that the endeavours to entertain the American Engineers met with so much appreciated success, and that they have left our shores with many recollections which will not easily fade away. The Guildhall banquet was apparently accepted as a great compliment, further enhanced when it was found that it was permissible to perfume the historic hall with the fragrant cigar. They also agree with all the rest of the world that a dinner at the Ship at Greenwich is a thing to be remembered. Beyond the good feeling that is always engendered by these friendly meetings, this particular visit has not been unproductive of practical results, if only for the publication by one of the Americans of another reason why people should drink old wine if put before them, viz., that one is compelled to imbibe it to save the enormous interest which is accumulating on it.

IN the annual report of the Commissioner of Police for the Metropolis, which was issued on Tuesday, it is stated *apropos* of vehicular traffic in London, that "changes in motive power are attempted, as by the use of compressed air and electricity." We hope that by this time next year the Commissioner will be able to report that electricity has been firmly established as a motive power on more than one metropolitan tramline.

# ON THE LIMIT BETWEEN POLARISATION AND ELECTROLYSIS.*

Note by M. H. PELLAT, presented by M. LIPPMANN.

LET us designate by $M$ the electromotive force that must be introduced on the circuit which connects the two mercuries of a Lippmann electrometer in order to render maximum the capillary constant of the small mercury. In the case in which the liquid of the electrometer is an acid, I have proved that the electrolysis of this acid is produced as soon as the electromotive force, $E$, introduced into the circuit is above $M$. In fact, hydrogen never appears when we get $E < M$, whereas it may appear, with the necessary precautions, as soon as we get $E > M$. We may often considerably exceed the electromotive force, $M$, without the hydrogen bubble forming; but electrolysis is produced all the same: if the hydrogen does not appear under the gaseous form, it is due to the general law that a gas can only be produced in a visible form in a liquid if there exists a gaseous bubble the diameter of which is above a certain limit; then, most probably, a highly saturated solution of hydrogen will be produced. This extreme saturation is avoided by creating a hydrogen bubble by an electromotive force far higher than $M$; the electromotive force is then brought back rapidly to a lower value, $E$; we then find that if $E$ is lower than $M$, the bubble does not increase in size; whereas, if $E$ is higher than $M$, the greater the value of $E - M$, the more rapidly does the bubble become enlarged.

This optical method of observing the electrolysis put me upon the track of the phenomenon, but it is not very convenient; I substituted for it a galvano-metrical process, which is susceptible of much greater precision and can be applied much more generally. We introduce into the circuit connecting the two mercury electrodes: (1) $E$, the electromotive force variable at will; (2) a Thomson galvanometer; (3) an interrupter. Moreover, we take for the small mercury a larger electrode ($\frac{1}{4}$ of a square millimetre). In order to avoid the polarisation of the other electrode, we can take a very large surface of mercury; but it is much better to take an unpolarisable system of electrodes (zinc in a salt of zinc); the constant differences of potential thus added to the chain do not signify, since we are only studying variations of electromotive force. The small mercurial electrode is plunged into the same vessel as the point of the capillary electrometer which serves to determine $M$.

We thus find that while $E$ is lower than $M$, on closing the circuit, the needle of the galvanometer receives an impulse due to the charge of polarisation, oscillates, and then becomes fixed at a position very near zero (spontaneous current of depolarisation); but as soon as $E$ is above $M$, the needle undergoes a permanent deviation which is relatively very great and in proportion to $E - M$. The sudden change in the sweep of the curve which represents the intensity of the current as a function of $E$, is very marked.

The truth of the law has been confirmed: (1) By the optical process for sulphuric acid expanded ($\frac{1}{6}$ in volume; $M$ = ·95 volts) and for the above-mentioned acid with the addition of $\frac{1}{2000}$th of bichromate of soda ($M$ = ·99 volts; (2) By the galvanometric process for the same sulphuric acid and for chlorhydric acid ($\frac{1}{6}$ in volume of acid at 21° B.; ($M$ = ·41 volts).

According to the views of M. Helmholtz, at the moment when the capillary constant is at its maximum, the double electrical layer, at the contact of the electrolyte and the mercury is *nil;* the law indicated above may therefore be stated thus:—

"*Electrolysis commences from the moment when the double electrical layer has been rendered nil by polarisation.*"

It is very probable that this law is applicable to any electrolyte whatever. But when it is a metal, *m*, which is rendered free by electrolysis, it forms an amalgam with the mercury of the electrode; this chemical modification of the surface of the electrode transforms the voltameter, $P$, into a battery, the electromotive force of which, of contrary nature, increases till it becomes equal to $E$, which allows of the passage of a very slight quantity of electricity. Thus in the case of the salts $E$ may greatly exceed the value of $M$, without the needle undergoing any important permanent deviation. However, by increasing more and more the value of $E$, a moment comes when the needle suddenly takes permanent deviations; the current then passes with an intensity proportionate to $E - K$, designating as $K$ a constant, which is the electromotive force starting from which electrolysis is produced continuously. We gather, in fact, that as soon as there is enough metal, *m*, in the superficial layer of the mercury electrode for this amalgam to act in a battery like the metal, *m*, itself (an amalgam containing less than $\frac{1}{500}$th of zinc acts like pure zinc), the electromotive force of the voltameter, $P$, cannot increase any more, and a constant current is produced, in virtue of the constant difference, $E - K$, of the opposing electromotive forces. For $E = M$, the difference of potential is *nil* between the pure mercury and the electrolytic liquid; for $E = K$ the difference of potential is *nil* between the amalgam of the metal, *m*, and the liquid, since the latter is a salt of the metal, *m* (*Comptes Rendus*, April 1st, 1889); but the difference of potential is not *nil* between the amalgam formed at the surface of the capillary electrode and the pure mercury further down, and this difference of potential is represented by $K - M$.

For the electrolysis of the sulphate of zinc, we get, in fact, $M$ = ·76 volts and $K$ = 1·27 volts; whence $K - M$ = ·51 volts. This last number only differs from the figures ·49 volts, which I obtained two years ago, for the difference of potential between the amalgam of zinc and the mercury by another method (*Comptes Rendus*, April 1st, 1887), by a quantity quite accounted for by the errors of these former experiments. Substituting for the sulphate of zinc, the hydrate of potassium, we get $M$ = ·29 volts, $K$ = 1·76 volts, whence $K - M$ = 1·47 volts. Thus the difference between the potassium and the mercury is + 1·47 volts.

If instead of electrolysing the hydrate of potassium we electrolyse a salt of potassium, we find for $K - M$ different values (1·39 volts with the chloride, 1·41 for the sulphate). But let us remark that the amalgam of potassium formed is attacked by the water, and that in the capillary tube a layer of hydrate of potassium is produced between the electrode and the earth; $K - M$ then no longer represents exactly the difference of potential between the mercury and the potassium; we must add to it the difference of potential between the hydrate of potassium and the salt employed. The truth of this remark is proved by the fact that if we introduce hydrate of potassinm between the salt and the electrode of mercury beforehand, we find that the electromotive force which it is necessary to employ, in order that the current may begin to pass continuously, is exactly the same as when the solution of the salt is brought directly into contact with the mercurial electrode. We see by these examples that there is a new method, both general in its application and convenient, for determining the true difference of potential between any metal whatever and mercury. But we also see that in its application we must guard against possible chemical reactions between the metal deposited and the electrolyte.

In a subsequent note we will indicate other methods for arriving at the same object.

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* *Comptes Rendus.*

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**Seeing Sparks.**—Mr. G. Crighton having witnessed overhead wires in Old Broad Street emitting electric sparks (caused by the contact of the wires) points out the danger to life and property therein involved, and recommends the City authorities to see that electric lighting companies have their wires properly insulated.

## THE ELECTRIC LIGHT IN BERLIN AND AT ELBERFELD.

*From "Le Bulletin de la Société Belge des Electriciens."*

### AT BERLIN.

As a complement to our article in the ELECTRICAL REVIEW of July 5th on "The Present Position of the Electric Light in Paris," we are now enabled, thanks to a lecture delivered by M. Wybauw, engineer of the City of Brussels, before the Belgian Society of Electricians, of which he is a vice-president, to lay before our readers an account of the electric lighting of Berlin and also at Elberfeld.

The working of the electric lighting of Berlin, said M. Wybauw, is carried on by several central stations, of which the two principal are situated in the Markgrafenstrasse and Mauerstrasse. Two small stations light the Kaiser-Galerie and the block of houses at the angle of Unter den Linden and the Friedrichstrasse. Another and unimportant station provides for the public lighting of the Leipzigerstrasse. The Markgrafenstrasse station is established in the street front. It comprises eight Kühn engines of 180 horse-power each, working 16 Edison dynamos. Quite recently there have been added four compound and condensing vertical engines of 300 horse-power each, built by the firm of Vandekerkhove, of Gand. These four engines work directly four dynamos of 1,500 ampères and 110 volts. The ring of these dynamos (Gramme) is outside the inductors, and is about 2 mètres in diameter. The number of revolutions per minute is only 86; thanks, however, to the large diameter, a sufficient periphery speed is obtained. The dynamos are multipolar; the current is collected by 10 brushes. There are eight steam generators; De Naeyer boilers placed on the first floor. The commutator chamber comprises an enormous rheostat, made by means of very fine galvanised ribbons of metallic cloth, through which the current is passed from a dynamo to where it is to be used; the various parts of the rheostat are placed in succession out of circuit, in order to cause the current to pass progressively into the line. The operator's guide is a voltmeter indicating the potential at the principal point of distribution of the circuit, by means of a measuring wire inserted in the cable itself. The exit of the current from the station constitutes an enormous bundle of at least 80 cables of varying section; the greater number of which, however, have a diameter of 7 to 8 centimètres with their coverings. These cables are on the Siemens system; the largest are up to 800 square mm. of section of copper. In the interior of the works these cables are replaced by flat copper bars, forming two groups. The first of these groups serves for the supply of the Opera and certain of the principal establishments; the second for the general canalisation. In case of accident, a general interruptor permits of cutting the current off so as only to maintain that for the theatres. The Mauerstrasse station comprises six Heine generators of 180 square mètres of heating surface, three steam engines of 180 horse-power, and three of 300. The Friedrichstrasse station has four 60 horse-power engines; that of the Kaiser-Galerie four 80 horse-power engines; and that of the Leipzigerstrasse two of 80 horse-power. It would be useless to describe these installations in detail here.* We think it may be useful to communicate to the members certain notes taken from the plans and documents furnished us, and relative to facts which we have not found in other works. The search for a position suitable for a central electrical station in a city is not without difficulty. The three Berlin stations, of which the generators are placed on the ground floor, have respectively:

| | | |
|---|---|---|
| 6 engines of | 180 H.P. | 526 square mètres of built surface. |
| 4 ,, | 300 ,, | |
| 3 ,, | 180 ,, | 413 ,, ,, ,, ,, |
| 3 ,, | 300 ,, | |
| 4 ,, | 60 ,, | 229 ,, ,, ,, ,, |

The growth of the station of Mauerstrasse and the two new stations in course of construction in Spandauerstrasse and Schiffbauerdamm furnish us with particulars for installations with more powerful motors:—

1. Mauerstrasse:

| | |
|---|---|
| 4 engines of 1,000 H.P., 557 square mètres | 1,044 square mètres of covered surface. |
| Generators on same level, 487 ,, ,, | |

2. Schiffbauerdamm:

| | |
|---|---|
| 6 engines of 1,000 H.P., 859 ,, ,, | 1,759 square mètres of covered surface. |
| Generators on same level, 900 ,, ,, | |

3. Spandauerstrasse:

| | |
|---|---|
| 4 engines of 1,000 H.P., with generators on ground floor ... ... ... ... | 572 square mètres of covered surface. |

As regards the placing of these stations, the principal consideration has been that of a central situation in the part to be lighted. The foundations of the engines are so fixed that shaking of the ground is not to be feared. Only anthracite is employed, so as to avoid smoke. The carrying of the coal is all done after 10 at night. Inconvenience has thus been almost entirely done away with. In passing through the Markgrafenstrasse one would doubt that between a fine novelty shop and a librarian's there is at work, facing the street, a station of several thousand horse-power. Water, which hitherto has been supplied by artesian wells, will shortly be taken from the Spree by means of conduits. Here is a plan of Berlin showing in red the present canalisation, which extends over a surface of about 10,000 square mètres. The same plan shows in blue the extensions which are about to be made, as the result of the agreement come to between the city and the company. These extensions will give an approximate surface of 45,000 square mètres lighted by electricity. The canalisation has been entirely constructed in Siemens cables. These cables are in leaden sheaths, which are covered with an insulating layer, which again is surrounded with an envelope formed of two iron ribbons rolled helicoidically and simultaneously round the cable; the whole being covered with tarred jute. In the interior of the cable is one wire smaller than the others of which the conductor is composed, and destined for the measure of the potential during the service. The cables, about 130 kilomètres in development, are placed on both sides of the street, under the footways. Their place is indicated by a band of mosaic pavement in small blocks. This canalisation appears to last fairly well; yet, lately, some accidents have arisen. In this connection, the English journals have published a lecture of Prof. Forbes read before the Institution of Electrical Engineers giving an account of a journey which he had made to Berlin, Rome, and Milan. Mr. Forbes spoke unfavourably of Siemens cables, basing his opinion on the accidents which happened as he was passing through Berlin. The *Elektrotechnische Zeitschrift* published the discussion which took place on this subject in the *Electrotechnische Verein*. Dr. Werner Siemens could not understand how so competent an engineer as Mr. Forbes could speak so lightly on this question. The oldest cables in Berlin date from 1885; the accidents have been noted only in the cables laid in 1886 and 1887. He cites the cities of Berlin, Munich, Rome, Turin, Milan, Mülhausen, Elberfeld, Darmstadt, Geneva, Salzburg, Lyons, La Haye, St. Petersburg, and Moscow, where the same cables are in use and keep perfectly insulated. A few accidents are always possible, he says, arising either from the manufacture or the laying, but one must not conclude from this that the system is bad. It is necessary to avoid, as much as possible, the neighbourhood of organic vegetable matters, which are capable, with the leaden covering, of producing carbonates or acetates; as to the galvanic action between the iron and the lead, it would have an effect on the iron but not on the lead.

M. von Miller, one of the directors of the Allgemeine Gesellschaft, gives details of the accidents which have been verified. There were five. The first must be attributed evidently to a blow from a pickaxe. The second was in connection with a cable enclosed in an iron pipe; the cause therefore was not mechanical, and a defect of manufacture or the effects of induction or charge must have caused a short circuit. In the last three it was not possible to define the cause with certainty, the iron and lead formed a molten mass; it is very probable that the accident should be attributed to the presence of organic matters in the soil. The new Friedrichstrasse cable was placed in a layer of clay. We remember, in this connection, that we laid in 1885, in a clayey mass, the electric cable which traverses the Grand Place at Brussels; it has remained absolutely intact to the present day. Without wishing to take part in this discussion, we will say that it appears to replace the asphalted jute insulator which separates the lead and iron by a more compact composition, which, while increasing the insulation, offers an opposition to the introduction of any humidity between the two sheaths, as also between the lead and copper. We have had a long experience, and are certain as to the manner in which India-rubber resists damp; but it is improbable that the insulator employed in Siemens cables, round the copper, is equal to India-rubber. The preservation of the leaden cover should therefore be complete and assured. The outer tarred covering appears to us not more than strong enough to guarantee the iron, when one reflects on the inevitable accidents which arise during the carrying and the laying, and, lastly, by the frequent excavations in the streets of a city. It would be preferable to dispense with this tarred covering, and to replace the iron spirals by a leaden sheathing of a certain thickness; then, to guarantee these cables against chemical action in laying them in a compact mass, clay or bitumen, and against the accidents arising from excavations in the streets, by means of a covering of thicker materials. We once used, with the latter object in view, simple tiles.

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* Full particulars may be found in Dr. Martin Krieg's "Die Erzegung und Verteilung der Electricität in Central Stationen" (Magdeburg, 1888: Faber.)

Long experience as to the manner in which, under public thoroughfares, iron or lead branches behave, induces us to say that an iron armature for electric cables is an excessive precaution against mechanical shocks, and, on the other hand, insufficient against chemical deteriorations. The oxidation of iron in the soil is very rapid, whatever the precaution taken to preserve it. It appears that at Paris what are called Flemish tubes are used. These are of fir balks, more or less deeply grooved, and closed by a lid. The wood used is subjected to an injection of sulphate of copper. A similar means has been employed in America, the wood being creosoted. It was found, however, that the creosote attacked the lead, which caused it to be replaced by sulphate of copper. When there are a certain number of cables, small cement drains are used in Berlin, in the interior of which are placed the naked conductors, borne by insulators. The drain is made by partitions in cement 4 or 5 centimètres thick, the core of which is a trellis of strong iron wire. The experience of these cement canalisations is not sufficiently advanced to allow of an estimate to be formed yet. At Paris, also, naked conductors are employed in conduits of cement. The armed conductors at Berlin were in the earth at a slight depth. At the street crossings there were, as junctions, large square metal boxes, 75 centimètres long by 25 centimètres high, furnished with tubes for the passage of the cables. These boxes are completely filled with an insulating oil, and closed by a bolted lid. The branches are made by means of smaller metal boxes of an elongated shape, and on an analogous system. The general potential in the line of distribution is 100 volts. In order to determine the dimensions of the cables, and recognise the necessity of an auxiliary cable or feeder of the line of supply, the central bureau has constructed in miniature a similar line to the real line, in giving exactly to all the conductors a proportional resistance to the real resistance. By this means, as soon as the delivery increases at one point of the line beyond the limits anticipated, account is easily and exactly taken of the modifications it is necessary to make. We enquired as to the manner in which the project for electric lines in Berlin was drawn up. Several diagrams were traced relative:—1. To the consumption of gas; 2. To the number of burners in use; 3. To the number of burners placed; 4. To the assessment of the land tax paid by the inhabitants. This work was done street by street, and from the combination of these different diagrams a total diagram has been deduced. This was, however, only a first indication, from which it was necessary, in reality, to deviate now and then considerably. A circular was addressed to the inhabitants asking them for useful information relative to lighting and motive power; this circular was accompanied by a tariff showing the conditions on which the electric currents would be supplied.

The most practical means, according to the Berlin engineers, was to found their basis almost exclusively on the number of gas burners lighted at once in important establishments. For private houses a lamp or a half lamp per lineal mètre of street was allowed, according to the class of the street. As to the establishments which have their own installations of electric light, Berlin prices are so far favourable that the addition of the greater number of these installations to the general line is looked for at no distant date. The supply of the electric current is continued during the 24 hours of the day. It is measured by Aron meters, the working of which appears to be satisfactory. During the night a single station performs the service of the whole line. Towards the evening the supply increases very abruptly; the curve of the ampères varies in a more considerable proportion than that known for gas. The present actual supply (November, 1888) of the Berliner Elektricitäts Werke Company is 2,200,000 watts, or the equivalent of 36,000 16-candle-lamps. A third of this total is taken by arc lamps. These figures do not include the Kaiser Galerie Station nor private installations; among the latter there are several theatres. The Berlin gas administration gives in its annual reports some information on the whole position of the electric lighting of the city. We take therefrom the subjoined figures:—

| | End of March, 1888. | | End of March, 1887. |
|---|---|---|---|
| Number of electric installations | 489 | ... | 333 |
| Number of arc lights ... ... | 2,249 | ... | 1,554 |
| Number of incandescent lamps | 45,552 | ... | 22,363 |

In 1888, according to the report dated April 1st, 1888, the number of electric lamps was 7·71 per cent. of the total of gas burners. The year before it was 4·1 per cent. The number of subscribers to the electricity company was about 400. The principal customers are the cafés, theatres, and shops, private consumers only reckoning as a small item in the total consumption. The actual verified division is as follows:—

| | |
|---|---|
| Cafés and restaurants ... ... | 10 per cent. |
| Shops ... ... ... ... ... | 34 ,, |
| Banks and offices ... ... ... | 21 ,, |
| Theatres ... ... ... ... | 27 ,, |
| Private houses ... ... ... | 4 ,, |
| Various ... ... ... ... ... | 4 ,, |

The following are the principal conditions of subscription. Branches are established by the company and paid for by the subscribers. The meters are placed and kept up at the following annual rates:—

| | | | Marks. |
|---|---|---|---|
| For | 10 | lamps of 16 candles, or their equivalent | 15 |
| ,, | 25 | ,, ,, ,, ,, ... | 20 |
| ,, | 50 | ,, ,, ,, ,, ... | 30 |
| ,, | 100 | ,, ,, ,, ,, ... | 40 |
| ,, | 600 | ,, ,, ,, ,, ... | 100 |

The base of the price of electricity is the quantity of current necessary to feed for an hour an Edison 16 candle English lamp; this price is 4 pfennigs (2½d.). From this is taken the following approximative table for lamps of other intensities:—

| | | | Pfennigs. |
|---|---|---|---|
| Lamp of | 10 | candles per hour ... ... ... | 2·5 |
| ,, | 16 | ,, ,, ... ... ... | 4·0 |
| ,, | 32 | ,, ,, ... ... ... | 8·0 |
| ,, | 50 | ,, ,, ... ... ... | 12·5 |
| ,, | 100 | ,, ,, ... ... ... | 25·0 |

Arc lamps pay for their consumption of electricity according to the same unit of quantity of current. Besides the prices set for the above, the subscriber pays six marks per year for the maintenance of each lamp installed. Lamps broken by fault of the subscriber are replaced at his expense. Reductions in the scale are made for lamps burning a specified number of hours per year, as under :—

| | | | | | | |
|---|---|---|---|---|---|---|
| For | 800 | hours this | reduction | is | 5 | per cent. |
| „ | 1,000 | „ | „ | „ | 7½ | „ |
| „ | 1,200 | „ | „ | „ | 10 | „ |
| „ | 2,500 | „ | „ | „ | 20 | „ |
| „ | 3,600 | „ | „ | „ | 25 | „ |

For the application to electro-motors a remission of 25 per cent. is granted when the subscriber instals a special meter.

The applications of electricity as a motive power appear likely to become of importance. A steam motor or a gas motor do not work, in general, so economically as when they work at full charge. Thus, in a printing office, the fire must be kept up and the boiler must work as well for one machine as for 10. With the electric current small electro-motors can be applied to each machine, if wished, and only the motors requisite need be worked. The prime motor and numerous transmissions are done away with ; no mechanic or boiler is wanted. The Berliner Elektricitäts Werke balance sheet for the period ending June 30th, 1888, its fourth year of existence, showed a profit permitting the distribution of a dividend of 5 per cent. on the share capital of 3,000,000 marks. We notice in this balance sheet the following figures for the different redemptions :—Personal property, 15 per cent. ; appliances, 40 per cent. ; lands, ¾ per cent. ; engines, 15 per cent. ; canalisation, 4½ per cent. There was also carried 2 per cent. of the net receipts to the renewal fund and 5 per cent. of the profits to the reserve fund. The contract by which the City of Berlin has conceded the working to the said company is a non-exclusive concession—that is to say, the city simply grants authority to utilise the streets for laying the cables. The annual rent to be paid by the company is 10 per cent. of the net receipts, plus 25 per cent. of the net profit exceeding 6 per cent. on the capital employed. The concession is granted for 30 years, but the city can purchase it after October 1st, 1895, on certain conditions. The security deposited by the company was 25,000 marks.

The public lighting of Unter den Linden is one of the most successful installations. Arc lamps of 15 ampères, enclosed in opal globes, are placed 40 mètres apart and 8½ metrès in height, along the footways. In the promenade, which occupies the central part of the thoroughfare, the lamps are suspended to chains, attached each side to candelabra. The latter are of a very artistic model, decided upon after a competition instituted by the city. The number of arc lamps is 108. For the service, the lamps are lowered by the aid of a cable with a counterpoise, placed inside the candelabrum. The conductors rise in the candelabrum midway ; thence they are visible and movable so as to allow of the working of the lamp. The reflector is fixed and protects the globe against rain and snow. The lamps are placed in series on nine different circuits, fed by dynamos placed at the central stations ; five circuits work up to midnight only. The extinction of all the lamps of a circuit would present no serious inconveniences, the circuits being alternate. The extinction of a lamp introduces, moreover, an equivalent resistance, so that the chances of the total extinction of a circuit are much reduced. We gathered no unfavourable information on this point, save in the offices of the city's gas service, where we were told that one or two general extinctions of the whole lighting had occurred. On account of the great number of separate circuits, worked three by three, by completely independent motors, general extinction is an evident impossibility, and we regard this information as erroneous. We hope one day to see our boulevards (Brussels) lighted thus. What proves the incontestable superiority of electric lighting over gas lighting in large streets and public places is the lighting of the façades. With gas the houses remain in great darkness, broken in some places by light from the lamps. With the electric light, on the contrary, the whole street is illuminated, and the houses appear throughout their height in the light, which recalls the aspect of the street during the day. The electric light will certainly produce the happiest effect with the white and neat façades of our Brussels houses. The old gas burners have been replaced on our boulevards by intensive burners. Many persons have not noticed the change, and yet the present lighting is five to six times stronger than the primitive lighting. *Apropos* of extinctions, Berlin has not yet dared to dispense with all precautions. Everywhere the lustres have retained their gas burners, either the old ones or new ones. But another reason than the fear of extinction guides the proprietors of public establishments ; that is, that in winter the warmth produced by the burning of gas is very favourable to the rapid warming of rooms. During the evening, when the temperature has risen, the gas is put out and the electric lamps lighted. At Berlin, it is becoming more and more the fashion to place arc lamps outside the large shops, occasionally in considerable number, fixed on candelabra or hung to ornamented consoles. The shop of the Allegemeine Gesellschaft, in the Friedrichstrasse, is very interesting to visit. Besides a large collection of lustres for electric lamps, we saw there electro-motors for small industries, notably, sewing machines, &c.

(*To be concluded.*)

## A PECULIAR GROUND.[*]

By W. L. P.

A SHORT while ago an incident happened in connection with the Edison three-wire system under Boylston Street, Boston, which is interesting both to the electrician and the chemist. It was noticed that the horses were very uneasy and somewhat scared when passing over an area of, say 10 feet square, in the granite pavement of the street. An investigation by the Edison people seemed to show no trouble, and everything went right for ten days or more, when, during a rain storm, the same action of the horses was noticed.

Upon digging down to the wooden box which contained the three wires of the system, embedded in some kind of tar or bitumen compound, a spot was found where the box was eaten through, and a large mass of sticky stuff was found around the negative wire. The insulation of the wire was destroyed, and as the neutral is dead grounded in the station there was a leakage, causing a fall of potential in the earth about the leak which was sufficient to affect horses as well as men. The leak was a small one and did not show at the station.

Chemical examination of the lump showed that it was originally concentrated lye which had become partly converted into caustic soda by water, and that the action of the currents had, by electrolysis, formed a considerable quantity of metallic sodium throughout the mass. There was sodium enough present to make a fair display of fireworks when thrown into a pool of water, and it is fortunate the workmen did not get into trouble in handling it.

My theory of the affair is this : In some way a piece of lye tumbled into the kettle in which the insulating compound was made and was not noticed when the box was filled. In time surface water got at this lump and converted a part into caustic soda, which destroyed the box and insulation of the wire (it only came in contact with one wire, the negative).

The escaping current caused a difference of potential at the surface of the ground which disturbed the horses. Metallic sodium was set free and would tend to collect at the negative wire.

The voltage at the escape was in the neighbourhood of 105 volts, and it was estimated by the touch that there was over 50 volts within the space that a man could reach with both hands.

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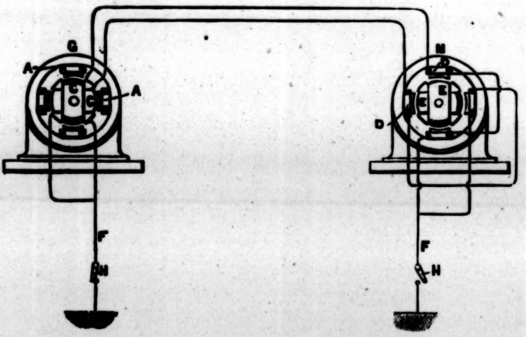
[*] *Electrical World.*

## THE TESLA SELF-STARTING ALTERNATING MOTOR SYSTEM.

As is well known, certain forms of alternating current machines have the property, when connected in circuit with an alternating current generator, of running as a motor in synchronism therewith; but, while the alternating current will run the motor after it has attained a rate of speed synchronous with that of the generator, it will not start it; hence, where these "synchronising motors," as they are termed, have been run, some means have been employed to bring the motors up to synchronism with the generator before the alternating current of the generator is applied to drive them. In some instances mechanical appliances have been utilised for this purpose. In others, special forms of motor have been constructed.

With the object of effecting the starting of the alternating motor and bringing it to synchronism without external aid, Mr. Nikola Tesla has devised a simple system in which he employs an earth return during the period of starting only. For this purpose he constructs a generator with two coils or sets of coils and a motor with corresponding energising coils or sets of coils. By means of two line-wires, one terminal of each generator coil is connected to one terminal of its corresponding motor-coil, while the opposite terminals of the generator-coils are joined together, and likewise those of the motor.



To start the motor an electrical connection is temporarily established between the points of connection, between the coils in the generator and those in the motor, so that the system becomes an ordinary double-circuit system. When by this plan of connection the motor has attained the desired speed, the earth connection is severed, by which means the system becomes an ordinary single-circuit synchronising system. The accompanying diagram from the *Electrical World* shows the manner in which this is accomplished, G representing an ordinary alternating current generator having four field poles, A, magnetised by a continuous current, and an armature wound with two coils, C, connected together in series. M represents an alternating current motor with, say, four poles, D, the coils on which are connected in pairs and the pairs connected in series. The motor armature should have polar projections and closed coils, E.

From the common joint or union between the two coils of both the generator and motor an earth connection, F, is established, while the terminals or ends of the coils which they form are connected to the line conductors.

Assuming that the motor is a synchronising motor, or one that has the capability of running in synchronism with the generators, but not of starting, it may be started by the above-described plan by closing the ground connection from both generator and motor. The system thus becomes one with a two-circuit generator and motor, the ground forming a common return for the currents in the two line wires. When by this arrangement of circuits the motor is brought to speed, the ground connection is broken between the generator or motor, or both, and ground switches, K, K, being employed for this purpose. The motor then runs as a synchronising motor.

## A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 11.)

### VI.—ARMATURES IN PRACTICE—(*continued*).

22. *Armatures of Class 3 Machines.*—In former articles we have treated of the armatures of *Class 1* machines in which the current supplied to the outside part of the circuit is alternating in direction, also in later articles of the armatures of *Class 2* machines in which the current is in the same direction but of a pulsating character. We have now to deal with the armatures belonging to machines of *Class 3*, which yield currents practically of steady flow.

In the machines of the second kind, which have occupied our attention in the last three articles, the total E.M.F. is the added E.M.Fs. of a few coils which may be always in circuit or thrown into the circuit only at regular intervals. Though these coils may be arranged in such a way as to make the fluctuation of the resultant E.M.F. a minimum by their positions of greatest activity occurring in regular succession, it will be obvious that the E.M.F. cannot be of uniform value unless the armature contains a large number of such coils. It is quite conceivable that we make a dynamo having on its armature 36 coils, wound in twice as many sections, instead of the two coils wound in four sections, as shown in fig. 111. Such a machine would undoubtedly give an E.M.F. practically uniform; but when we reflect that if constructed with split-ring commutators it would require no less than 36 of them, having as many pairs of brushes connected in series, we see at once that the mode of construction is impracticable, and that for the collection of currents from machines which are to give a uniform E.M.F., some simpler device must be resorted to. But that this device must be in some way equivalent to a number of commutators, such as we have described, is also apparent.

We have seen that the E.M.F. induced in each coil or section is in a two pole machine reversed in direction twice per revolution; and from this it follows that in all the active wires extending over half the circumference of the armature, the E.M.F. is induced in the same direction, while in all the wires extending over the other half, the induction is in the opposite direction. This is true so far as the conductors are concerned, whatever the number of coils or sections and however connected to the commutator. In the diagram, fig. 118, N and S are north and south poles,

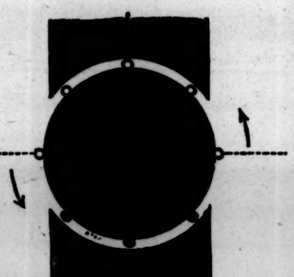


FIG. 118.

A being the armature core and the small circles on its exterior representing the active wires. The motion of the armature being in the direction of the arrow, all the conductors on the half circumference, *a*, *c*, *b*, will have the induction in such direction as to send a current into the paper, as shown by the black circles while in the wires on the half circumference, *a*, *d*, *b*, the induction will be such as to make a current flow in the opposite direction, as shown by the white circles. A section may, of course, consist of any number of these conductors connected together.

The function of the commutators, shown in fig. 111, is to connect together the ends of the coils so that their E.M.Fs. shall always be combined to send the current in the same direction, and the commutators of machines giving steady currents must perform the same office. In fig. 119 is shown a ring core with two sections diametrically opposite whose ends are connected in parallel to a split ring commutator. On rotating this armature between two poles we should get a result similar in character to that obtained from one coil of the arrangement in fig. 111, but the E.M.F. is now halved, since it is due to one section only instead of two in series. Double the current could, however, be carried by this arrangement. Now, imagine that the whole of the ring is wound over with wire in a large number of sections lying close together. If constructed with split ring commutators there would be for each of the two sections, on diametrically opposite sides of the ring, one commutator, and the arrangement might be represented as at fig. 120, where A, B, C, D, E and F represent the six adjacent commutators for an armature of twelve sections, G, H, J, K, L, &c., being six adjacent sections occupying half the circumference of the armature. The connections of the sections to their respective commutators are clearly shown, and for each commutator there is one pair of brushes marked 1, 2; 3, 4; 5, 6, &c., the pairs being joined in series, 2 with 3, 4 with 5, and so on. The circuit through the armature has its terminations at brush 1 and brush 12. Clearly the function of the intermediate brushes is to connect the sections together that they may all combine to send the current in the same direction. Brush 2, for instance, being connected to brush 3, joins the end of section H with the beginning of section J, while 4, being connected to 5, joins the end of J with the beginning of K. The combination of commutators and brushes has the effect of converting the winding of the armature thus composed of sections into one endless helix, and that the E.M.Fs. of the separate sections may be added, it is only necessary that the segments terminating the ends of diametrically opposite sections should be brought under the brushes when these sections occupy in the magnetic field the position of reversal. For the complicated arrangement in fig. 120 we can substitute a much simpler device, which will fulfil the essential condition of reversing at the right moment the connections of the section to the external part of the circuit. This device consists in substituting for these split ring commutators a number of parallel bars, as shown in fig. 121. These are carefully insulated from each other, and form, when laid together, a polished cylinder, upon which rests a pair of brushes. The contact surface of the brushes, when resting on the commutator, is sufficiently wide to bridge over the insulating material between the bars, and the continuity of the circuit is thus maintained. To each bar is connected the end of one section and the beginning of the next, as shown in the figure, the bars taking the place of the commutator half rings correspondingly lettered in fig. 120.

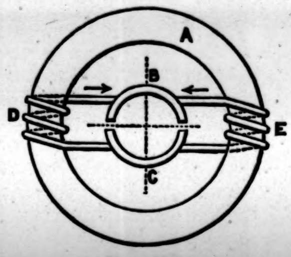


FIG. 119.

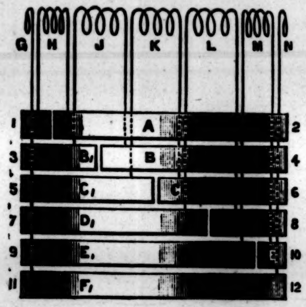


FIG. 120.

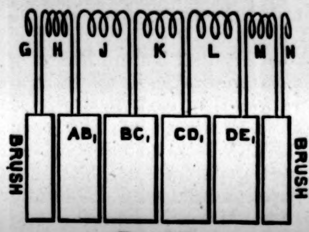


FIG. 121.

In figs. 120 and 121 the armature winding is in two parallels, the E.M.F. being that induced by half the exterior wires connected in series. This is rendered more clear in fig. 122, which shows the armature with its 12 sections joined up to 12 commutator bars, and also the collecting brushes, A and B. It will be seen that just at the moment when the direction of the induction is reversed in a section, the bars terminating its ends pass under the brush, its connections relatively to the brush being consequently reversed. The current splits into two equal portions, half going through each half of the helix, as shown by the arrows. That there is no essential difference between the arrangements shown in figs. 120 and 122, will now be apparent. But for a large number of armature sections the latter construction is essential, while for an armature having few coils the former is most suitable.

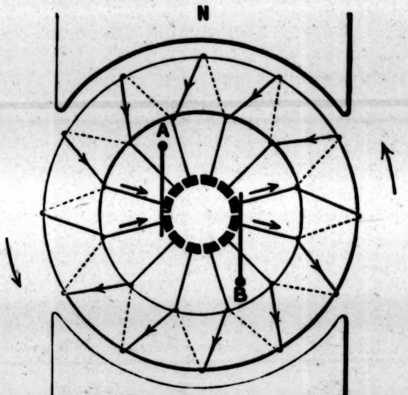


FIG. 122.

If N be the total number of lines of force passing through the ring core, each conductor on the exterior of the armature cuts in passing from one brush to the other N lines, or, in one revolution, 2 N lines. If $s$ is number of revolutions per second, the lines cut in a second are 2 N $s$, and the average E.M.F. in volts induced in each exterior conductor $= \frac{2\,\mathrm{N}\,s}{10^8}$. The total E.M.F. of the armature is that due to half the number of conductors on its exterior, or $\frac{w}{2}$ if $w$ is the number of conductors, whence the E.M.F. induced is

$$\mathrm{E} = \frac{2\,\mathrm{N}\,s}{10^8} \times \frac{w}{2} = \frac{\mathrm{N}\,s\,w}{10^8} \text{ volts.}$$

The E.M.F. is practically steady when the commutator has 24 sections, and it is seldom that dynamos having commutators made in this way possess a less number.

(*To be continued.*)

# THE ELECTRIC LIGHTING SCHEMES.

## *Petitioners Before the Commons Committee.*

### LONDON ELECTRIC SUPPLY ORDER GRANTED.

ON Tuesday last, before the following Select Committee of the House of Commons: Sir George Trevelyan, Sir H. Roscoe, Mr. Duncombe, and Mr. Story-Maskelyne, a considerable number of petitions were heard against the Bills which had been read a second time, and under which Provisional Orders for electric lighting had been granted by the Board of Trade. By these Orders power was given to the London Electric Supply Corporation, Limited, to light the parish of Chelsea, part of St. Mary Abbot, St. George's, Hanover Square, St. James's (Westminster), St. James's and St. John (Clerkenwell), part of St. Martin-in-the-Fields, part of St. Margaret and St. John the Evangelist, part of Lambeth, part of St. Mary, Newington, and the districts of St. Saviour, St. Olave, Rotherhithe, Bermondsey, and Greenwich. The Order of the Westminster Electric Supply Corporation comprised the area of St. George's, Hanover Square, and part of St. Margaret and St. John (Westminster); that of the Electricity Supply Corporation, Limited, included the parish of St. Martin-in-the-Fields; that of the House-to-House Electric Supply Company, Limited, gave power to lay mains in the parish of St. Mary Abbot, Kensington; that of the Kensington and Knightsbridge Electric Lighting Company, Limited, also to light a portion of St. Mary Abbot and the parish of St. Margaret, Westminster, to the west of St. George's, Hanover Square; that of the Notting Hill Electric Lighting Company, Limited, to light also a portion of the parish of St. Mary Abbot, Kensington; that of the Chelsea Electricity Supply Company, Limited, to light certain large squares and crescents in South Kensington; to the Metropolitan Electric Supply Company, Limited, was apportioned for lighting the parish of Lambeth and the parts of the parishes of Streatham and Clapham, in Wandsworth, the St. Giles (Bloomsbury), Holborn, and Strand districts, and the parish of St. Marylebone. Two important provisions in the Orders are as to overhead wires and the protection of telegraph and telephone companies. The first is: "The undertakers shall not, without the express consent of the County Council, place any electric line above ground, along, over, or across any street or public place, or (except in the case of any electric line so placed by themselves before the commencement of this Order, and during the time limited by this section for the removal thereof) supply energy by means of any electric line so placed. Seven days before commencing to lay down any electric line, or to supply energy through any electric line, in any manner whereby the work of telegraphic or telephonic, or electric signalling, communication through any wires or lines lawfully laid down or placed in any position may be injuriously affected, the undertakers shall, unless otherwise agreed between the parties interested, give to the body or person for the time being entitled to such wires or lines notice in writing specifying the course, nature, and gauge of such electric lines, and the amount and nature of the currents intended to be sent along the same, and the extent to and manner in which (if at all) earth returns are proposed to be used; and the undertakers shall conform with such reasonable requirements as may from time to time be made by such body or person as aforesaid for the purpose of preventing the communication through such wires or lines from being injuriously affected as aforesaid."

The counsel in this case were Mr. Pember, Q.C., Mr. Moulton, Q.C., Mr. Loyd, and Mr. Graham for the London Electric Supply Corporation; Mr. Pope, Q.C., Mr. Bidder, Q.C., and Mr. Danckwerts for the St. Margaret's and St. John's (Westminster) Vestry; and Mr. Freeman on behalf of the London County Council.

Mr. **PEMBER** opened the proceedings by saying a few words as to the procedure in the cases before the committee, and then explained the area which the London Electric Supply Corporation was authorised by the Board of Trade to light. There would, he said, have been no opposition to the preamble of his Bill had it not been for the united parish of St. Margaret and St. John, Westminster. The capital of the company was a million and a quarter, of which £800,000 was subscribed, and £500,000 or £600,000 was paid up, and a half of that was spent. They began operations by taking the Grosvenor Gallery station, from which they supplied more than 33,000 lights. The experience gained there had led them to the conclusion that it was a bad thing to have generating stations in populous neighbourhoods. Their intending system, therefore, was to have one large generating centre outside London, at Deptford, with trunk mains coming up along the railway companies lines and over the bridges carrying the electricity at a very high pressure to local stations inside London, where the high pressure would be converted into a low tension, and the distributing mains, which would carry it from the conversion stations along the streets, would be connected by wires to the houses of consumers, where it would be converted again into a handy pressure, so as to enable it to be laid on to different rooms in the house. The system of lighting adopted by the London Company was the alternating system as opposed to the direct system of storage batteries. The new feature of the London Company's adoption of the alternating system was the generation of the electricity and its first distribution at a very high pressure indeed. The pressure in their trunk mains was a pressure of 10,000 volts at the converting station. The pressure was altered by a well-known instrument called a converter to a pressure of 2,500 volts, at which it was carried along the streets in the distributing mains. Wires then went off to single houses or buildings and the 2,500 pressure was reduced to 100 or 50 as it was required in a handy form, and there would be one converter for every 10, 20 or 30 houses. One of the great contentions of his company had all along been that they had never asked for an exclusive grant of an order to light any district, for they had never opposed competition. They were quite ready for any other company to come in provided his company was not excluded, for theirs was the best system, and the one which the customers would ultimately adopt. His company feared no competition and desired no favour. Mr. Pember proceeded to deal at length with the petition of the parish of St. Margaret and St. John the Evangelist, and was speaking of the crossing of Westminster Bridge, whereupon

Mr. **POPE** urged that it was stated that the crossing of Westminster Bridge as proposed was neither practical nor desirable.

Mr. **PEMBER** replied that he knew that the London County Council would ask for a clause prohibiting the use of any bridges unless the work was carried out in a manner approved by their engineer. He would contest their right to such a clause, although his company was perfectly willing to submit the matter to an independent arbitrator, supposing the work was not done satisfactorily by their own engineer. The provisional orders, Mr. Pember continued, did not grant any monopoly of lighting, so that the request of the opposing local authority for a postponement of the lighting of the united parishes of St. Margaret's and St. John was not necessary. The parish authorities did not want the electric light to be admitted into their parish.

Mr. **POPE**: They never said so, and do not think so. But they do object to this order.

Mr. **PEMBER**: They asked that the order should stand over for a year for further consideration. If that is not a refusal to admit the electric light into the parish I do not know what is. Mr. Pember then alluded at length to the following clauses in the petition:

"Your petitioners humbly submit that the effect of the bill will be to authorise considerable interference with streets and thoroughfares under their control. Part of their parish will be allocated in connection with another area of London to the London Company, and part will be allocated to the Westminster Company.

"Your petitioners have no reason to believe that any considerable demand exists at the present time for the supply of electric light within their parishes by either of the said companies. The grant of the said orders would permanently dispose of the electric lighting of the main portion of your petitioners' parishes in a manner which your petitioners regard as unsatisfactory. They humbly submit that the confirmation of the said orders is premature, and that they ought to be deferred, in order that more time may be given for the consideration of the subject, so as to enable the settlement of this important question to be effected, as regards your petitioners' parish, on a more satisfactory basis, whether the powers conferred by the General Acts are to be exercised by your petitioners or by a company.

"Your petitioners are advised and believe that the whole scheme of the London Company is of a very experimental character, and that there is great reason to doubt whether it will be ultimately successful.

"Your petitioners would further point out that under the express provisions of the general Electric Lighting Act of last session (section 1) no Provisional Order authorising the supply of electricity within the district of any local authority can be granted except with the consent of the local authority unless in a special case their consent is dispensed with as therein set forth.

"Your petitioners desire to point out that they have not consented to the said Orders, or either of them, and they deny that any sufficient special reason exists why their consent should be waived, and they object to the Bill being proceeded with so far as relates to their district."

Mr. PEMBER proceeded to contend that the petitioners' claim was to exclude the company from passing through their parish, which meant the denial of access to parishes beyond their own. The admission through their parish so far simply meant the laying of a trunk main to get through. The claim of the local authority to interfere with the distribution of electricity throughout the district was inadmissible. The very first paragraph of Major Marindin's report was to the effect that the science of electric lighting had reached such a point that it could be supplied with advantage to the public, thereby negativing at once the assertion that the time had not yet come when the electric light could be properly supplied. The exclusion of his company from the area of the petitioners would injuriously affect the far larger and more important parishes beyond. Several of the paragraphs of the petition altogether failed. The preliminary fight between the company and the petitioners had been settled before the Board of Trade, and the committee had only to decide the merits of his application.

Mr. POPE, Q.C., then addressed the committee on behalf of the vestry, and said he would recall the memory of the committee to the contested matters which had resulted in the passing of the Act of 1888. The electric companies complained that the legislation of 1882, by enabling local authorities to step in and acquire on the terms prescribed in that Act, the whole undertaking of electric lighting if they chose, acted as a deterrent upon investigation and, preventing capital being invested in the enterprise, acted injuriously to the progress of electric lighting. Thereupon an application was made to Parliament for an extension of the terms, and, being opposed by the local authorities, the result was that the Act of 1888, which was practically a compromise between the two conflicting interests, was passed. As the law stood before the Act of 1888 the Board of Trade granted a license for electric lighting in any district irrespective of the veto of the local authorities, but the local authorities would have had the opportunity of acquiring the possession of the undertaking at the expiry of 21 years. The legislation of 1888 did this—it gave the electric lighting companies an extension of time to 42 years, providing that the acquisition of their undertaking should not take place before 42 years, but it gave to the local authorities a prohibitory power subject to the supervision of the Board of Trade. He considered that he was entitled to raise the point that the consent of the local authority had not been obtained by the London Electric Supply Corporation. He had that morning, however, received a special report from the Board of Trade dispensing with the consent of the local authority, but he did not understand why at that time the consent was dispensed with.

The CHAIRMAN and the other members of the committee complained that they had not a copy of the special report, and that they could scarcely follow Mr. Pope unless they had. Upon copies being ultimately obtained for the committee,

Mr. POPE resumed, and said the Board of Trade had no right to dispense with the consent of the local authority unless it set forth the reasons for so doing, and it had not done so. It was a hardship to override the consent of the local authority without giving adequate reasons for it. Then as to the question of carrying the mains over Westminster Bridge, it was thought not to be practicable by the vestry. The view which the vestry took was not hostile to electric light, but that they were bound to secure such a supply of light as should be available for the poorest parts of their district, and therefore they asked the committee to defer the order for a year so that they might have an opportunity of fully investigating the various systems of lighting by electricity. Electricians would tell them that it was at least an experiment whether the establishment of a generating station at a place outside a district like Deptford could accomplish the supply of a district so remote as Westminster. Not only were the vestry justified in asking, but they were entitled to ask for another year. The withholding of the consent of the local authority was not in itself perhaps sufficient to stop the inquiry, but he was entitled to say that where there was a special report, the Board of Trade waiving that consent, it was necessary to show adequate reason for so doing.

The CHAIRMAN said he thought they had got as far as they could by argument unsupported by evidence, and the question was whether the committee had a right to go into the objections of the local authority. He had no doubt whatever that they clearly had such a right. At present all that they had before them, besides the speeches of the learned counsel, were the objections in the petition and the special report of the Board of Trade. He would like to know if evidence was to be brought forward.

Mr. PEMBER: Yes, certainly.

The CHAIRMAN: In that case you had better go on.

After some discussion as to whether any official on behalf of the Board of Trade should be examined,

The CHAIRMAN said that as to the method of supply by the company the committee did not wish to go beyond the long report of the Board of Trade. They considered that that report was authoritative, but, on the other hand, the special report just issued did not give the committee all the information that they wanted, and therefore on that point it would be necessary to take evidence. He need not criticise the report, and would only say that it was not enough for the committee, and as to the special objections of the vestry they would have to take evidence.

Mr. MOULTON, Q.C., said he did not know whether, under the circumstances, an official of the Board of Trade ought to send in a further report in writing to the committee, or whether some one should be examined to give them information.

Mr. POPE replied that he knew how valuable Major Marindin's information would be, but he did not think it was competent for the Board of Trade to supplement their special report by evidence. The Provisional Order came forward with the dissent of the local authority which had been waived by the Board of Trade without having disclosed their special reasons for so doing.

Mr. DUNCOMBE: Had the local authority the opportunity of putting their objection before the Board of Trade?

Mr. POPE: We attended the inquiry before Major Marindin, but never had the opportunity of putting our objections before the department.

The CHAIRMAN: The committee have to decide this question on its merits, and we do not wish to criticise the special report of the Board of Trade. We have no course now except to go into the evidence which bears upon the objections of the vestry, leaving out the case of the method of supply.

MR. POPE: They must make out a *primâ facie* case for invading our district.

**LORD CRAWFORD** (chairman of the London Electric Supply Corporation), examined by Mr. Moulton, Q.C., said that he had given great attention to the work and system of the corporation, both from an electric and scientific point of view, as well as from the question of finance.

MR. MOULTON: Is it a rich and powerful company capable of carrying out the work which is alluded to in this Provisional Order?—Yes.

And as to the system adopted, are you of opinion that it is capable of doing the work satisfactorily?—Yes.

Do your consider the area of St. Margaret's and St. John is necessary in order to enable it to do the work on the north side of the river?—Yes: it is very desirable that it should be added to our area, for there is no public bridge by which we have access to that parish but the Westminster Bridge.

Has your company had any applications for lighting this portion of St. Margaret's and St. John?—We have had a considerable number of applications from houses which would require about 4,000 lights.

And in your opinion is that a district in which the electric light would be useful?—I should say there would be probably 30,000 lights required in Victoria Street. It is very largely let out in flats, in which the electric light would be readily used.

This is a district in which electric light would be largely used, and have you any reason to think that your company would not be able to supply the light effectively in that area?—There is no reason whatsoever.

Will the granting of that area enable you to light the other areas more satisfactorily by reason of its geographical position?—Undoubtedly it will. If we are forced to run into Chelsea with a main running down to a butt end, we shall not get the same advantage as if the main were brought back in another direction. It would be more difficult to make the supply satisfactory, and we should really be forced into the position of not being able to have a double system of the route by which to work, and therefore to carry out the instructions of Major Marindin's report.

Is it important for public safety and convenience to have such a double route?—For public convenience it is most desirable to have a double route. By public safety, I apprehend you to mean the danger of extinction. If so, it is undoubtedly desirable.

(*To be continued.*)

## NOTES.

**Electric Lighting at Exeter.**—At last week's meeting of the Exeter Town Council, a letter was read from the Secretary to the Electric Construction and Maintenance Company, Limited, giving notice that it was the intention of the company to apply to the Board of Trade in the next session of Parliament for a Provisional Order to supply electricity in the Council's district. The Devon and Cornwall Electricity Supply Company, Limited, Plymouth, forwarded notice of their intention to apply to the Board of Trade for a Provisional Order, to be confirmed by Parliament in the Session of 1890, to authorise the supply of electricity for public and private purposes in the area of the City of Exeter, for such period as the Board of Trade might think proper. It was hoped that the Council would consent to such application. Mr. Fulford moved that the letters should be referred to the Parliamentary Committee. Mr. Varwell seconded. Mr. Norrington moved as an amendment that the communications should be simply received and acknowledged, and this was carried. Mr. Fulford then moved that it should be an instruction to the Town Clerk to prepare, through the Parliamentary Committee, a report as to how the several applications that had been made affected the interests of the citizens. It was time, he remarked, that the Council should be forearmed with a knowledge of what powers these companies were seeking. It would be very regrettable a few months hence to find that they were not in time to protect the interests of the citizens. The motion was agreed to.

**Electric Lighting at Liskeard.**—At the last meeting of the Liskeard Town Council, a letter was read from the secretary of the Devon and Cornwall Electricity Supply Company, requesting the consent of the Council to an application to the Board of Trade for a Provisional Order authorising the company to supply electricity for private and public purposes in the urban district of Liskeard. In reply to Mr. Foster, the Town Clerk said that if the company did obtain a Provisional Order, they would not enjoy a monopoly of the supply of electricity in the borough. On the suggestion of Mr. Glubb, it was decided to defer giving consent.

**Electric Lighting at Bournemouth.**—The Anglo-American Brush Electric Light Corporation, Limited, and the Electric Construction and Maintenance Company, Limited, have submitted an application to the Poole Town Council for their consent to applications for Provisional Orders made to the Board of Trade in pursuance of the Electric Lighting Acts of 1882 and 1888, authorising the supply of electricity within certain portions of the borough. The application will be considered at the Council's next meeting.

**Rival Electric Lighting Companies at Chatham.**—At a meeting of the Chatham Board of Health on Friday last notices were read from the Municipal Electric Light and Power Corporation, the South of England House-to-House Electric Company, Limited; and the Electric Construction and Maintenance Company, Limited, each stating the intention to apply to the Board of Trade for powers authorising them to supply electricity for public and private purposes within the district of Chatham. Mr. De La Cour: They are speculators. The Clerk: It is not only a question of giving notice; they have to get your consent before they can make any application to the Board of Trade, but the companies do not appear to recognise that. It is in the discretion of the Board to grant whatever applications they desired, and to say whether there should be one, two, three, or four companies. Mr. Randall: I think we should acknowledge the letters, and ask each company to forward a copy of the order they intend applying for. It was then resolved to adopt Mr. Randall's suggestion.

**Lighting at Erith.**—The Erith Local Board have given their sanction to an application from Captain J. H. Thompson, R.A., to erect poles along the Bexley Road at Erith, for carrying two electric lighting wires, the gallant captain undertaking the entire responsibility in the event of any accident being caused by the wires, and to indemnify the Local Board in regard to any claim arising therefrom. It may be mentioned *en passant* that having become tired of the system of lighting by gas, the authorities at Erith adopted oil lighting for the public thoroughfares, but the experiment has not been popular on account of the stench emitted by the oil lamps, and also because of the frequency with which the lamps are found out. It is therefore probable that at the next consideration of the lighting question, the electric light and its advantages will be seriously considered.

**Electric Lighting in New York.**—The crusade against overhead wires in New York has been actively maintained; but the inhabitants of that city find themselves, as it were, "between the Devil and the Deep Sea;" for although they are now freed from an aërial enemy, they are becoming alarmed at the periodical explosions in the subways; and where underground lines have not yet been put down, many localities are, since the removal of the overhead wires, in almost complete darkness.

**Electric Lighting in Edinburgh and Leith.**—The Edinburgh Town Council on Tuesday remitted to the Lord Provost's committee to consider and report as to the advisability of the Corporation applying for a Provisional Order to supply electricity for any purpose within the City of Edinburgh. Half-a-dozen companies have notified their intention of applying. At a meeting of Leith Town Council on Tuesday it was reported that five electric lighting companies had given notice that they would apply to Parliament for a Provisional Order to supply the burgh with the electric light. Baillie Archibald expressed the opinion that the Council should not allow any company to come into the town to get 10, 12, or 15 per cent. dividend, and ultimately have to be bought up by the Corporation. The Council had the monopoly of lighting, and they should consider carefully before they allowed such companies the power they sought. The matter was remitted to the general committee for consideration.

**Electric Lighting at Johnstone.**—At the last monthly meeting of the Johnstone Town Council, a letter was read from the secretary of the House-to-House Electricity Company, Limited, asking the consent of the local authority to make application to the Board of Trade for a Provisional Order to supply electricity to the town. It was agreed to refuse consent. The Provost thought they should call a special meeting of the Town Council to take the whole question into consideration, as to the propriety of making application for power to provide electricity so far as they may be requested to do so. This was agreed to. Similar applications have been made to other towns in Scotland with like results.

**Electric Light and Gas Shares.**—Last week, at the usual monthly meeting of the Town Council of Airdrie, a letter was read from the Electric House-to-House Lighting Company, and in the course of a discussion, Baillie Rankine thought the scheme was a most important one, and deserved the consideration of the Town Council. The question was remitted to the Fire and Lighting Committee, which caused Baillie Arthur to remark that "most of them would now be considering the advisability of selling their gas shares." It was reported that one large shareholder had "sold out" some days ago.

**A Chance for the Electric Light.**—Estimates are required for the lighting of the district, consisting of the entire area of the parish of Carshalton, with gas, oil, or other illuminant, at per lamp, exclusive of the cost of columns, frames and lanterns, for 12 months, from 31st inst., for the Local Board. Tenders, marked "Public Lighting," and addressed to the Chairman of the Board, must be deposited at the Board Offices, High Street, at or before 12 noon on 24th inst.

**Train Lighting at Buenos Ayres.**—Some little time back an accident occurred on a train running between Buenos Ayres and Rosario, owing to the explosion of a kerosene lamp used for lighting a compartment. The Government of the Republic has now decided that no mineral oil is to be used in passenger coaches, and that the coaches at present being constructed are to be arranged so as to receive the electric light. Experiments are being made to test the comparative merits of lighting by compressed gas and electricity.

**Electric Lighting in France.**—An electric light installation has been inaugurated at Saint-Hilaire-du-Harcouët. The station is at Varoux, about two and a half miles distant, where water-power is used. Two water-wheels drive a Thury dynamo of 600 volts and 17 ampères.

**The Electric Light in Switzerland.**—A central station has been established at Lucerne, which feeds 22 arc lamps in the public streets at £16 per lamp per year. Private persons will be allowed the benefit of the use of the mains laid, under conditions which have yet to be settled.

**"Progress in England."**—Our French contemporary, the *Bulletin International de l'Electricité*, is sarcastic under this heading. They point to Colonel Haywood's report to the Commissioners of Sewers on the trials made with Defries oil lamps, and say: "In France and Belgium, countries behind date, electricity is employed for lighting; in England they experiment with petroleum."

**The Electric Light in Liverpool.**—On Tuesday the question of lighting the principal thoroughfares of Liverpol by means of electricity was again discussed by the Watch Committee, the members of which were engaged for some time in considering the draft of the provisional order prepared by the Electric Supply Company, Limited. The decision of the committee was to instruct the city engineer to report in each instance as to the proportion of expense to be borne by the company, and it was arranged that in all cases of dispute the matter should be submitted to arbitration.

**Electric Light at Alnwick Castle.**—The operations in connection with the introduction of the electric light to Alnwick Castle are steadily progressing under Messrs. Drake & Gorham. The motive power is water. The dynamo is to be driven by a turbine to be situated in the locality of the Abbey Mills. From there conductors will be carried on poles to the Falconer's Tower where the battery room will be placed. About two miles of wire have already been taken through the Castle, and before the work is finished as great a quantity again, and more, will have been utilised.

**Celluvert.**—We have received from Messrs. D. Moseley and Sons, of Manchester, samples of celluvert, a new substance, consisting of converted or changed cellulose, of cotton or other vegetable fibre, and said to be superior to similar preparations in composition, strength, durability, and uniformity. It is made hard or flexible, and in three colours—white, red, and black—and is supplied in sheets, tubes, and sticks. We understand that the material is produced in America, and that Messrs. Moseley and Sons are appointed sole agents for this country, the continent, and the colonies. We may have something further to say as to the merits of the article as a non-conductor of electricity after we have had an opportunity of testing it.

**230 Miles per Hour.**—A New York correspondent says that the latest invention for rapid transportation of mails is being introduced by the Post Electric Company. It consists of an elevated railway track of a new design, for a car made of magnetised steel and running upon a single rail. It has been exhibited in Boston, and explained by Prof. A. E. Dolbear, of Tufts College, who announced that, after a very thorough examination and testing of the discovery, he was certain that a car could be run from New York to Boston, a distance of some 230 miles, in one hour. He explained that while the new plan will at first be devoted to letter carrying, and by it there can be a mail from city to city several times every forenoon, afternoon and evening, it will be entirely possible to carry people as well as the mails, and that this will before very long be done. We are surprised that a man of Prof. Dolbear's standing should countenance this preposterous notion.

**Moss Side Local Board.**—At a meeting of the General Purposes Committee the assent of the board was given to the proposal of the Manchester House-to-House Electricity Company to supply electricity for public and private purposes within the board's district.

**The Late Sir Charles Bright.**—The value has been sworn at £1,274 of the personal estate of the late Sir Charles Tilston Bright, of Bolton Gardens and Golden Square. By his will, made in 1880, he leaves to his wife all his property, real and personal, excepting his patents and interest in patents, and his office furniture and books, which he bequeaths to his brother, Mr. Edward Brailsford Bright, whom he appoints sole executor of his will.

**Selecting Electric Light Conductors.**—The Wiring Tables about to be issued by Messrs. Woodhouse and Rawson will doubtless save much labour while calculating the dimensions of electric light leads. But can the figures given therein be implicitly followed? Apparently, no notice has been taken of temperature effects, so that a wire, carrying a current of a density of 1,000 ampères per square inch, is considered as having the same resistance when the current is increased to a 3,000 ampère-density per square inch. In reality the temperature of the wire must have risen nearly ten-fold, and the resistance, in consequence, much increased. The table in this case must be inaccurate, showing an excessive length of wire for a given fall of potential and current density. The Table I. would be greatly improved by giving the rise of temperature with each length, or printing it in isothermal lines. The figures in blacker type represent data that should not clash with any insurance rules. We cannot see the utility of publishing particulars of leads carrying 4,000 ampères per square inch, unless the intention is to make the leads serve a double purpose.

**Horse Grooming by Electricity.**—There has been an application of the electric motor to a horse grooming machine in the stable of Marshall Field & Co, 46, Pacific Avenue, Chicago. This is probably the first application of the kind in Chicago. The motor is a 3 horse-power Sprague machine running at 1,650 revolutions at 220 volts. The grooming machine is so geared that two revolving brushes run at about 2,500 revolutions per minute. Previous to the use of the electric motor the machine was driven by horse-power.

**Electricity in Spain.**—Madrid advices report that the Sociedad Espanola de Electricidad, which was the first to introduce the electric light into Spain, has entered into an arrangement with an English company in order to continue its operations. The *Economista*, referring to the matter, says:—"It is truly lamentable that a company such as the Espanola, which was founded in a spirit of the purest patriotism, with the object of constructing its own machinery and of using native-made motors, should now have to hand over its business to foreign makers, whose first object will be to prevent the manufacture of electrical machinery in Spain."

**The Edinburgh Electrical Exhibition.**—The Edinburgh Town Council has declined the request of the secretary of the proposed Exhibition of Electrical and Mechanical Inventions, to grant the use of the East Meadows in the centre of the city as a site for the Exhibition. At the same time the Council voted a sum of £1,000 to the guarantee fund, provided they were satisfied as to the site and other arrangements. The Exhibition Committee are on the outlook for a suitable site.

**Personal.**—Mr. Arthur Wright, formerly of the Brighton Electric Light Company, informs us that he has been engaged since May last in assisting Mr. Ferranti, of the London Electric Supply Company, Limited.

**The Manufacture of Incandescent Lamps.**—Under an arrangement made between the Edison-Swan United Electric Light Company and the Anglo-American Brush Electric Light Corporation, Limited, the latter company discontinues the manufacture of Victoria incandescent lamps in the United Kingdom. With regard to the lamps now in use, the arrangement is that the Brush Company's customers shall not be disturbed or prevented from using such lamps, unless the Edison-Swan Company wish to replace them by lamps of their own manufacture, in which case they shall carry out the substitution without charge to customers.

**Sound-Reading.**—Mr. Patrick Delany (of multiplex fame), in a paper read before the Franklin Institute, made the statement, "I doubt if there be on the entire continent of Europe an operator that could copy 30 words per minute by sound for five consecutive minutes. Our operators have to do this, or very near it, all day long." Without venturing to contradict the latter assertion we may state that in the Postal Telegraph Department in England there are scores of operators who habitually receive on the sounder for the entire day, at a speed exceeding 30 words per minute, and a rate of 40 words per minute is by no means uncommon.

**The Shah and the Phonograph.**—Colonel Gouraud recently introduced the phonograph to the notice of the Shah of Persia, at Lord Brownlow's Castle. The Shah was delighted with the performance, and, smiting his palms together, cried "Oh! Oh!" and "Wonderful." He also expressed a great desire to possess the instrument, and, although it is all but the only one in Europe, Colonel Gouraud agreed to let him have it. As Prince Malcolm Khan stated, the Shah will take it at once to Teheran, and he wants some one to go with him to work it. Here, says *Invention*, is a chance for an enterprising electrician! But why electrician? *Invention* belies its title by suggesting that electricity has anything to do with Edison's latest phonograph, in which even the driving electro-motor has been abandoned.

**A Prosperous Electrical Firm.**—The pressure of orders for electric lighting installations, &c., is so great at the works of Messrs. J. H. Holmes & Co., Portland Road, Newcastle, that the firm have decided to enlarge the works.

**An Overcrowded Profession.**—"Yes," she remarked proudly, "my husband is a member of one of the foremost professions of the age. He is an electrician." "Is he with Edison?" "No; he is a brakeman on one of the new Fourth Avenue cars."—*American Exchange.*

**The Queen's Prizeman.**—The winner of the Queen's Prize at Wimbledon is Sergeant Reid, of the 1st Lanark Engineers. He is only 26 years of age, and is a telegraph operator in Glasgow. His nerve, under the very trying conditions, appears to have been admirable, and we congratulate the young telegraphist on his success.

**Graham Bell's Wonderful House-Boat.**—Professor Graham Bell, that ingenious native of Edinburgh to whom the world is indebted for the telephone, is spending the summer in Cape Breton, where, in addition to a picturesque cottage at Baddeck, he has a magnificent house-boat in which he cruises about, always with a goodly company of friends on board. The boat has spacious apartments, double parlours, billiard room and every imaginable convenience. It was built for the special accommodation of guests for whom Mr. Bell found it would be impossible to secure quarters in the primitive farmhouses of Cape Breton. This boat was planned by the distinguished inventor himself, aided by a skilled architect from Baltimore, and it is believed to be the finest thing of the kind in the world.—*Christian Leader.*

**Killed by an Electric Light Wire.**—An enquiry was held at Brighton last week into the death of a man who had lost his life by coming into contact with an electric light wire. The deceased, Thomas Garman, 32 years of age, was night watchman at Messrs. Hallett and Abbey's Brewery, and it was part of his duty to go to the roof to examine the liquor vat. Suspended at a height of between 4 and 5 feet over the stand from which this inspection was made was an electric light wire, and the other morning Garman was found lying there dead, with a mark half way round his neck, as if grazed by the wire. A medical examination proved the man to have been perfectly healthy, and it was the opinion of Dr. Lowe that Garman had been killed by the electric current, his neck by some means coming in contact with the wire. The jury returned a verdict accordingly, and expressed an opinion that the wire, which had no communication with the brewery, had been very unsafely hung. It was only five weeks ago another man received a bad shock from the wire.

**The Leeds Electric Light Enquiry.**—Can it be possible that want of funds precluded the Electric Lighting Committee of the Corporation of Leeds, as a body, from finishing up their list of trips and rambles, in search of the best form of lighting plant, by a fortnight's visit to the Paris International Exposition? There, no doubt, their experience could have been much enlarged by the examination of the numerous installations erected on foreign models—unless, indeed, the members of the Committee were too patriotic to even become acquainted with, much less to think of, recommending the adoption of the manufactures of any country but their own. Their report, which we commented on about three weeks ago, contains no mention of a trip to Paris directly, but indirectly there is evidence that some of the Committee had been over to La Belle France, and although they have found there nothing in the electrical line worthy of adoption, still they have returned imbued with those notions of chivalry and politeness for which our neighbours are so renowned. We are all aware that the arc light is trying to the complexion, and in consequence is not admired by the fair sex, whose opinion on the subject may be summed up in the words of a lady we casually overheard say, "This light is fit for nothing but to light up statuary;" but, as the fashions of the days of Pericles and Phidias are no longer in vogue, the committee have shown their gallantry by advising the Corporation of Leeds to substitute, for all indoor purposes, incandescent lamps in place of arc lights, which latter, their report states, "from the paleness of the light, as compared with the incandescents, throws a somewhat unnatural light upon the features." If a little of this light had been thrown into the brains of the gentlemen constituting the committee of electric lighting, it might have enabled them to decide, in a somewhat shorter time than six years, that, except for small powers, steam was preferable to gas as a prime mover; that, before the Brockie-Pell lamp was invented there was an arc lamp with steady light, and that the intermittent or probably careless use of accumulators does not tend to a long life of the plates. We trust, however, that the forthcoming installation at Leeds may give as much satisfaction to the inhabitants, in a practical sense, as the confidence which the committee have in their own ability, without the aid of professional assistance, to carry out the same successfully, does to that body. Something must have been learned in six years.

## NEW COMPANIES REGISTERED.

**Westinghouse Electric Company, Limited.**—Capital £600,000, in £10 shares. Objects: To acquire the patents, goodwill, business, and property of the American company known as the Westinghouse Electric Company, and to manufacture and deal in every kind of engine, machine, wire, lamp, or appliance capable of being used in connection with the utilisation or generation of electricity. Signatories: *Sir Hy. W. Tyler, M.P., Pymmes Park, Edmonton; *Francis Pavy, Foley House, Portland Place; *John Dixon Gibbs, 18, Warwick Street, Regent Street; Wm. D'Oyley, 24, Westbourne Terrace (100 preference shares each); C. Colin Macrae, 26, Cheyne Walk, Chelsea; Hy. Rudolph Laing, 3, Drapers' Gardens (20 preference shares each); Hy. Turton Norton, 57½, Old Broad Street (10 preference shares). The signatories denoted by an asterisk, and G. Westinghouse, jun., and S. Humbird, are the first directors; qualification, 100 shares each; remuneration, £2,000 per annum, to be divided as they may determine. Registered 11th inst. by Norton, Rose & Co., 57½, Old Broad Street.

**Ruston, Proctor & Co., Limited.**—Capital £250,000 in £10 shares. Objects: To take over the business of agricultural and general engineers carried on by Joseph Ruston, at Lincoln and elsewhere, trading as Ruston, Proctor & Co. Power is taken to construct electric, water, or gas works, to generate, store and use electricity for any purpose, and to carry on the business of an electric lighting or storage company, or electrical engineers. Signatories (with 1 share each): *Joseph Ruston, J. T. Tweed, Lincoln; *G. M. Hutton, Gainsboro'; *A. E. Tylor, 117, Leadenhall Street, E.C.; S. Mosley, R. F. Allured, 104, King Street, Manchester; *Theodore Fry, M.P., Darlington. The signatories denoted by an asterisk are the first directors; qualification, £1,000 in shares or stock; the company in general meeting will determine remuneration. Registered 12th inst. by Grundy, Kershaw & Co., 19, Southampton Buildings, W.C.

**Woodhouse & Rawson United Company, Limited.**—Capital £350,000 in £5 shares. Objects: To effect an amalgamation of the following companies, viz., Woodhouse and Rawson, Limited; Woodhouse and Rawson Electric Supply Company, Limited; Woodhouse and Rawson Electric Manufacturing Company, Limited; Woodhouse and Rawson Electric Contract and Maintenance Company, Limited, and C. L. Baker & Co., Limited. Signatories: Lord Aberdare, P.C., Mountain Ash; Philip Rawson, Crawley, Sussex; Lieut.-General Sir John Stokes, K.C.B., Haywards Heath; Sir John Coode, K.C.M.G., 35, Norfolk Square; Sir A. J. Leppar Cappert, K.C.I.E., 11, St. George's Terrace, S.W.; C. Edward Howard Vincent, C.B., M.P., 1, Grosvenor Square, 1 share each; F. L. Rawson, 68, Cornwall Gardens, 2,000 shares. The signatories are to appoint the first directors; qualification 50 shares. The company in general meeting will determine remuneration. Registered 12th inst. by Johnson, Budd & Johnson, 24, Austin Friars.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Latimer Clark, Muirhead & Co., Limited.**—The annual return of this company made up to the 4th inst. was filed on the 11th inst. The nominal capital is £100,000 in £10 shares. 4,709 shares have been taken up and the full amount has been called and paid thereon.

**Anglo-American Brush Electric Light Corporation, Limited.**—The annual return of this company made up to the 27th March was filed on the 11th inst. The nominal capital is £400,000 in £5 shares. The shares taken up are 26,763 upon which £5 per share has been called, and 25,517 upon which £4 per share has been called. The calls paid amount to £235,877, and unpaid to £6. The sum of £18 has been paid upon six shares forfeited.

**Henley Telegraph and Electric Construction Company, Limited.**—The registered office of this company is at 6, Clement's Lane, Lombard Street, E.C.

## ELECTRIC MOTOR FOR ALTERNATING CURRENTS.

PROF. GALILEO FERRARIS, of Turin, who has carefully studied alternating currents and secondary transformers, has constructed a little motor based upon an entirely new principle, which is as follows: If we take two inductive fields developed by two bobbins, the axes of which cut each other at right angles, and a pole placed at the vertex of the angle, this pole will be subjected to the simultaneous action of the two bobbins, and the resultant of the magnetic actions will be represented in magnitude and direction by the diagonal of the parallelogram, two consecutive sides of which have for their length the intensity of the two fields, and for their direction the axes of the two bobbins.

If into each of these bobbins we send alternating currents having between one bobbin and the other a difference of phase of 90°, the extremity of the resultant will describe a circle having for its centre the vertex of the right angle.

If, instead of a fixed pole, we use a metal cylinder movable on its axis, we shall obtain a continuous rotatory motion of this part, and the direction of the movement will change when we interchange the difference of phase in the exciting currents. This rotatory movement is not due to the Foucault currents, for the metal cylinder may consist of plates of iron insulated from each other.

In order to realise the production of these fields, several means can be employed: The current is sent from an alternating current machine into the primary circuit of a transformer and thence into one of the bobbins, the other being supplied by means of the secondary current of the transformer. A resistance introduced into the circuit will produce the required difference of phase, and the equality of the intensities of the fields will be obtained by multiplying the number of turns of the secondary wire on the bobbin. Moreover, the two bobbins may be supplied by the secondary current of a transformer by producing the difference of phase, as in the first case.

In the motor constructed by Prof. Ferraris the armature consisted of a copper cylinder measuring 7 centimetres in diameter and 15 centimetres in length, movable on its axis. The inductors were formed of two groups of two bobbins. The bobbins which branched off from the primary circuit of a Gaulard transformer, and were connected in series, comprised 196 spirals with a resistance of 18 ohms; the bobbins comprising the secondary circuit were coupled in parallel, and had 504 spirals with 3·43 ohms resistance. In order to produce the difference of phase, a resistance of 17 ohms was introduced into the second circuit, when the dynamo produced a current of 9 ampères with 80 inversions per second. Under these conditions the available work measured on the axis of the motor was found for different speeds: Revolutions per minute: 262—400—546—650—722—770. Watts measured at the brake: 1·32—2 12—2·55—2·77—2·55—2·40. The maximum rendering corresponds to a speed of rotation of 650 revolutions, and Prof. Ferraris attributes the loss of work for higher speeds to the vibrations to which the machine is exposed. At present the apparatus is but a laboratory one.—(*Bulletin International de l'Electricité.*

# CITY NOTES, REPORTS, MEETINGS, &c.

## The Eastern Telegraph Company.

IN the report presented yesterday the revenue for the six months amounted to £435,932 3s. 10d., from which are deducted £92,448 14s. 6d. for the ordinary expenses and £48,665 14s. for expenditure relating to repairs, renewals and laying of cables, &c., during the half-year. After providing £3,710 5s. for income-tax there remains a balance of £291,107 10s. 4d., to which is added £36,616 1s. brought from the preceding half-year, making a total available balance of £327,723 11s. 4d.

From this amount there has been paid, in interest and dividends, £98,748 15s. 10d., leaving a balance of £228,974 15s. 6d., from which £118,000 has been carried to general reserve.

The directors recommend the declaration of a final dividend for the year ended 31st March, 1889, of 2s. 6d. per share and a bonus of 3s. per share, amounting together to £110,000, both payable on the 18th instant, free of income-tax, and making, with the three previous payments on account, a total distribution of 13s. per share, or 6½ per cent. for the year on the ordinary shares. The balance of £974 15s. 6d. shown at the foot of the revenue account is proposed to be carried forward to the next half-year.

The revenue includes £81,441 12s. dividend and bonus for the half-year upon the company's investments in the Eastern and South African, the Black Sea, and the Direct Spanish Telegraph Companies.

Since the last general meeting the Eastern and South African Telegraph Company has completed the extension of its cables along the West Coast of Africa, connecting Cape Town, Port Nolloth, Mossamedes and Benguella with Loanda, where the cables of the West African Telegraph Company terminate, thus establishing an alternative line of telegraphic communication between Europe and the Cape of Good Hope, and completing the telegraphic circuit of the African Continent.

The directors believe that this work will be satisfactory to the shareholders, which is largely interested in the Eastern and South African Company, and to the public.

An agreement has been entered into between this company and the other telegraph companies interested in the South African Telegraph business, by which the telegrams to and from South Africa will be transmitted either by the East Coast or the West Coast route on joint account, and the receipts divided between them in equitable proportions.

A convention has been entered into between the French Government and this company for laying a cable between the company's station on the island of Perim and the French settlement of Obock.

The several sections of this company's cables are in good working order.

At the meeting Sir John Pender occupied the chair. The minutes having been read, the Chairman, after going minutely into the accounts, drew attention to the fact that when he was last before them he had said they were engaged on the very important work of completing the system round the West Coast of Africa. That work, he was glad to say, was now completed. Taking now the two lines together, no less than 17,201 miles of submarine telegraphy had been laid, and that enormous work could not have been accomplished without organisation. He considered the money for which he had asked last time was very profitably invested. What they had always aimed at was an international system, and all the civilised world recognised the fact that it would be impossible to live without their telegraphic system. The Indian traffic had considerably decreased, and that was due largely to the merchants having got their code to such a state of perfection that very large messages could be sent by the aid of very few words. He could not blame the merchants, but they must take care not to put on the screw too hard. Notwithstanding the very encouraging prospect, they had a large amount of work before them, as cables were getting old, and it would be necessary to replace with new ones.

Captain Goodsall, amid interruptions, questioned about the advertising, and considered the amount for the half year as too heavy.

Sir John Pender said the amount was £450, £130 of that is for the *Electrician*. As I told you before, this paper belongs to myself and a few other gentlemen interested in electricity. We did not start the paper for the purpose of making money out of it; we return all the paper earns to the men who write the scientific articles. We send copies of the paper to every station, to enable our young men to see what is going on; it is done for the benefit of our staff, and not so much to enlighten the public, and it is not to put money into our pocket.

The motion was then put to the meeting and adopted.

A vote of thanks to the chairman brought the meeting to a close.

## London Electric Supply Corporation.

AN extraordinary general meeting of this company was held last Monday, at Cannon Street Hotel, for the purpose of approving the accounts for the past 15 months. Lord Crawford occupied the chair. After the notice had been read convening the meeting,

The Chairman said: Gentlemen, we have met to-day in order to carry out the promise which your board made at our last meeting, when they presented their annual report, and told you then that they were about to lay the accounts of the past year before you. The business that we have to-day is to lay those accounts before you, which I believe have been already circulated. Before going into any question of these accounts I wish to inform you that the board has been materially strengthened by the addition thereto of Mr. James Forbes, who has come upon the board as vice-chairman and chairman of the finance committee. Your directors, in requesting Mr. Forbes to take this position among them, thought they were doing the very best for the interests of the shareholders in carrying out this arrangement. Mr. Forbes has been good enough to go very carefully into all matters relating to finance, and he will explain to you the whole of the accounts which are now laid before you. I may say that the form in which the accounts have been printed and produced now are mainly on the lines laid down by the Board of Trade for the accounts which are to be presented by all electrical companies in the future; they are based somewhat on the lines of the accounts which are produced annually and laid before Parliament by the gas companies, and I think they will be found sufficiently wide. Without entering into the matter, I will move that the accounts now submitted be approved. I will ask Mr. Forbes to go into the question of the accounts and also answer any questions.

Mr. Forbes: Gentlemen, in seconding the resolution that the accounts be approved, I think I had better avail myself of the opportunity of the accounts being first submitted to the shareholders to deal a little with them in the order in which they appear in the printed documents before you. It is very desirable at starting that the proprietors should be thoroughly versed in these accounts, and probably the wisest plan will be to deal with the position of the business at the most recent period, that is to say, the quarter of the year terminating on March 1st. These accounts, as you know, ought to have been submitted in the year ending December 31st, but there were reasons which prevented that being done, and the directors thought it would be desirable, as some considerable time has elapsed since then, that you should be, so to speak, posted to date, therefore, on the first sheet of the account you will see set forth the statement of the capital at various periods, statement of the share capital on December 31st, 1888, and of the loan capital. Since then, as you were made aware at your last meeting, there has been an alteration in the method of raising the capital of the company. If you will follow me through the statement of accounts you will see exactly where we are, both in respect to the resources of the company which have been called up, and also of that latent power which is so desirable in the case of a company that is on the verge of great undertakings. The capital is £1,000,000 divided into 200,000 ordinary shares of £5 authorised by the articles of association, the number of shares issued 111,000, called up £5 on 92,300 giving £461,500, and £4 upon 18,700 giving £74,800, that brings up your amount of share capital paid up to £536,300. You will see that upon the 18,700 there is £1 still to call which is in the nature of resource for future requirements, then in accordance with the resolution of the general meeting held December 21st, 1888, £250,000 preference capital was authorised, and of that 50,000 shares have been issued, their record per share being £1, then there remains unissued £445,000 on the ordinary shares, it is very material to know that over and above the amount of capital already called up so much has been subscribed to meet the requirements of the company from time to time. Besides the £200,000 unpaid in capital on the preference stock, £18,700 upon the shares £4 paid, you will have the power of issuing the remaining capital of £445,000, that is material in this sense that the authorities dealing with the application of electric lighting companies for licences or whatever they are called, required a very strong assurance that they were not merely bogus companies endeavouring to get licences to hawk them about to someone else, they would only entrust them to companies having a substantial back up. If you will kindly go to the next statement you will find it in two forms, capital account to 31st December, 1888, and capital account to the 31st March, 1889, though the resolution of the 21st December, 1888, authorising the creation of preference shares and the re-arrangement of your then method of raising capital has been put into operation, and the 1st March statement shows exactly how it stands; you will see a great alteration between the two statements. You then had at the end of December £384,000 raised in money: you now find that you have raised £586,300; representing £461,500 ordinary shares at £5, 74,800 £4 paid, and 50,000 preference shares £1 paid, so that, in fact, since December the total amount of money received or receivable has risen from £384,000 to £586,300. On the next page you will see that money has been applied, and if you will turn to the account of December you will see the £374,617 has been spent up to that time, and as the works are going on and money spent from time to time, so that the expenditure up to to-day has been £392,957 14s. 1d., and the balance is £193,342 5s. 11d. I shall now make a few remarks on the revenue account. It has been put out in great detail in order that the directors themselves and the shareholders may be able to understand what are the general heads of expenditure involved in an undertaking of this kind, and what are the details making up the several heads. You will see what the heads are: Generation of electricity, distribution of electricity, rent, rates, and taxes, management, and legal expenses. The generation of electricity is shown in a number of items: coals, oils, engineers' salaries, repairs, &c.; that means, in fact, cost of creating the electricity or power which has to be distributed afterwards. For the purpose of creating this electric light, you have the work at the Grosvenor, and the great work which has been carried out at Deptford, which will in course of time supersede the Grosvenor, these expenses representing the cost of production, so to speak, of your article, the power is made in one place, and it has to be distributed to a great number of other places. Distribution is a totally different process, and is conducted through different machinery; this requires expenditure in the way of salaries, repairs, maintenance, wayleaves, and so forth, which are fully set forth under the heading of distribution of electricity. Administrative charges are more or less fixed in their character, except in the relation and proportion to the charges, such as the charges of electricity and distribution, which depend upon the amount produced and consumed. On the opposite side of the account we come to what is the kernel of the whole nut; what is the result of this large expenditure of capital, and of these large sums spent for production and distribution? The result will be, you will have a great number of customers who will pay sooner or later such reasonable charges for the article they consume as experience dictated to be the rate of charges, and out of that you have to get a return for your expenditure and the interest on your capital. I suppose no shareholder in this company—I have only had the honour of joining it recently, and have a great deal to learn—will suppose in the inception of a business of this sort having to contend with such great difficulties would, in the first period of its existence, at once burst out into a position of great prosperity. What we have to consider is whether the initiatory period which must of necessity involve excessive expenditure on the one hand, and comparatively small revenue on the other, is of such a character as to induce in the minds of reasonable men the belief that the undertaking is sound. At the other side of this account you get the income which has been derived from this expenditure. Sale of current per meter at 7½d. per B.T.U., and under contracts £24,141; and there are certain other small items such as rentals and meters, apparatus, sale of apparatus and other items, bringing in a revenue of £24,989, £25,000 in round numbers. The eye naturally wanders down to the other figures—expenses, £26,000, and if the eye were to wander there in future and found no more satisfactory result, I daresay you would not be very hopeful about it. It seems by this account that during these 15 months of what may be called the initiation of this business the income was absorbed by the working expenses. Just consider for a moment what was going on—a broken kind of business, few customers compared with the expenses of generation, and a great deal of the current that was generated not utilised at all. I think I may put it in general terms—if all the current which was produced for £26,000 could have been distributed, sold, and paid for, the result, instead of being a very small balance against you, would have been a balance in your favour, but in the very nature of things I think you will have to submit to the account. There was more electricity generated than you could sell, that is the natural kind of things when you consider the circumstances. In order to test whether that is starting upon a sound foundation we have had the revenue account for the three months ending 31st March made up. During these months the concern was still in a state of transition, still wanting customers, and you must remember the public are slow to follow in this business, and only by degrees, as confidence is inspired, do they give orders, and when orders were given it was not wise or easy to immediately execute them. You know what has been going on in Parliament. The regulation of electric companies has been under the consideration of the Board of Trade, and they have had to consider who is to be deputed to undertake this business and upon what conditions. During the time these discussions have been going on it is easy to understand why not only the directors have held their hands, but why the public did not come in as rapidly as they would do and will do when these points are settled, and when they know they are dealing with a legally constituted company. Coming back to the revenue account of the three months, you will see a change for the better. The accounts are made up in exactly the same detail and order, and except there being a loss of £382 on the working expenses as there was in the account of the 15 months, there is a profit of £584 in three months. That is not a very large profit upon the capital spent; it is useful as indicating we have turned the corner, and the same observation as I have made as to the generation and distribution of electricity holds good in that quarter as it did in the previous year. Well, what is going on is this, knowledge and experience, and scientific investigations and application are bringing things into harmony, and, doubtless, in another three months will bring the business into much more equilibrium than it is now; generation will bear a much nearer approximation to your distribution and sale power than it does at the present moment. What the board are waiting for is the completion of the great works at Deptford; these works are, of course, very bold, they are very costly, but they will, when finished, at a comparatively small relative charge, do what smaller works would not have done, they will put you in possession of the means of supplying an increased demand at a price which could not have been done by any multiplication of places on a much smaller scale; to create at one centre an enormous amount of electricity and by conducting to various parts of London, to reduce the cost of production and the fixed charges of production at the least possible figure. I think I have said enough upon the question of the revenue accounts; although the 15 months are not very profitable to look upon, three months under the influence of more experience, reduced cost and more customers, has presented rather a better aspect, and I need hardly tell you that if £548 for a quarter goes on rapidly being multiplied, as everybody this side of the table thinks it will, when the directors have the pleasure to meet you, the result will be a good deal more satisfactory; I have nothing further to add, and therefore second the resolution moved by the noble lord.

A few questions were asked by one or two shareholders, which were answered by Mr. Forbes.

The Chairman then put the motion that the accounts be adopted to the meeting, which was carried unanimously.

Lord Crawford then said: This closes the work which we have to do to-day, but probably it will be desirable that I may say a few words on the state of your property since I had the honour of addressing you. At that time I told you that we were doing all that we could with regard to obtaining Parliamentary consent for doing our work underground instead of overhead. Overhead wires were very useful, but entail considerable labour and considerable risk to ourselves. When I say risk, I do not mean risk of danger, but risk of interference, owing to the inefficient means of our obtaining any permanency for these cables, because they are always at the mercy of a single individual, who may say, "Take the pole off my house," and if you have to do that, and you cannot get a way, you practically break off the whole circuit. On the 21st December we had prepared, and I showed you at that time, proposals which we were then placing before the Board of Trade as to granting of statutory powers. I also showed you a map, which was coloured, with a great streak of red over it, showing that we were proposing to take over a very large portion of the metropolis. We had many interviews with the local authorities, and in many cases the desires which we had formed met their views. Having arranged as near as possible with various bodies, we went to the Board of Trade and presented our proposed order. We had many interviews with them, but we could not persuade the Board of Trade to take our views altogether, and they determined, at the instance of the local authorities and others, to hold what is called a legal enquiry, which was commenced on the 3rd April of this year, and extended continuously sitting for a period of 18 days. During that time Major Marindin, who was the inspector, heard before him all the objections that could have been raised to the orders he had before him. In course of time he made a report to the Board of Trade, which has since been presented to Parliament. With regard to the report I have no objection whatever; on the contrary, I am perfectly well satisfied with what we did, and I think the shareholders will have every reason, also, to feel satisfied with it. We have been given powers over 13 local authorities in London. Beginning at Deptford we have the Greenwich parish, Rotherhithe, Bermondsey, St. Saviour's, St. Olave's, a portion of Lambeth, Chelsea, St. Margaret's and St. John's, Westminster; St. George's, Hanover Square; St. James's, Westminster, and a portion of St. Martin's-in-the-Fields; in addition, Clerkenwell has been added to the order. Since that recommendation was made the parish of Newington, in South London, applied to the Board of Trade, saying that they would be deprived of the light unless we were allowed to go, and therefore Newington was added to the list; we have therefore a very large area over which we have jurisdiction. The main principle in Major Marindin's report was that, where it is possible, two companies should be put in the same area; that, you recollect, was entirely our view; we were opposed to monopoly, and perfectly willing that wherever we had powers that other companies should have powers also, relying upon our being able to do work in a business like manner. The areas in which we have competition at the present moment are as follows: - In St. George's, Hanover Square, we have against us, or alongside of us, the Westminster Company; that company has powers over St. Margaret's; in Chelsea we have the Chelsea Company alongside of us, in our portion of St. Margaret's we have alongside the Metropolitan Company, and, again, also the Metropolitan Company extends its power over a similar portion of Marylebone parish, over which we have taken jurisdiction, the parishes lying to the east of Lambeth on the south of the river are served by us alone, no other companies have been promoted for the working of that district, though I have no doubt that others will come and seek to have powers alongside us, all we have to say is, we do not object to their coming. There is one important recommendation in Major Marindin's report which ran to this effect, in our generating station down at Deptford, Major Marindin thought it would be desirable to split up the building into two portions longitudinally, or that we should have another generating station. I showed that the dividing of the engine room in the manner in which he suggested was not possible, and also that the dividing it up would not really carry out his desires, that is, that every large engine should be insulated, practically have a wall or something of that description between it and its neighbour. I also showed that the advantage to the public was one with advantage to the shareholders, that if anything is to be done the money had far better be spent upon another plant and generating station in an advantageous part of London. The Board of Trade are willing that that should be done, and we shall commence the erection of another station in another place. As to what has occurred since I last had the honour of speaking to you on 21st December, you will remember early in April last year we commenced work upon our Deptford land; very little had been done then except the pulling down of some brick sheds that were lying there; since that time we have put up suitable buildings, and are in a very fair way of commencing to take active proceedings. We have made a building, consisting of boiler-houses and engine-houses, which cover an area of 40,000 square feet; the cubic capacity of those buildings runs up, if I remember rightly, to some 3,000,000 cubic feet; the boiler-houses are to the exient of 12,000 H.P., and have been tested up to 300 lbs., and are again being tested to a higher rate. We have erected and run two engines of 1,500 H.P., which can be started and worked in a very short time now. Possibly many of you may remember that a short time ago we had an unfortunate accident—a steam pipe breaking—which was practically the fault of no one; it was owing to the inherent qualities of copper under pressure, apparently some chemical action is set up which renders the copper unsafe; this accident, I am grieved to say, resulted in the death of an unfortunate labourer. It caused us to take down the steam connections from these engines and test them up to a much higher pressure than they had been put to previously, and these connections are now being made, and I trust in a very few days the engines will again be able to be actually worked. The dynamos which are to be worked by these 1,500 H.P. engines are in a very definite stage of completion, and in a short time these machines will be working, each machine being able to do more than the Grosvenor Station is able to do at the present moment. When we start at Deptford we shall be able to relieve the working of the Grosvenor to the extent of some 15,000 lights. The Grosvenor Station, as, I think, was noted just now, would be done away with in course of time; but we do not wish to stop the working at the Grosvenor until we are absolutely going so far that we can wipe out the Grosvenor station; consequently the Grosvenor will go on for four or five months. However, we shall be able to work the Deptford plant before the powers that we seek to obtain are granted to us. When Parliament is good enough to confirm the Orders which have been made, we have certain formalities in the Order which are laid upon us before we are allowed to do anything to the streets. We are not allowed in future to lay overhead wires, our work has to be done underground. We have to give notice to the local and other authorities before we are allowed to break the ground. If we get our Orders this month it may be supposed that we should be able to begin in September, but that is not so, for all the local authorities put in the Orders that no portion of the month of August shall count as a month; therefore, if we get the Orders on July 31st the whole month of August will be wasted, and we shall only be able to give our month's notice on September 1st and begin to break the ground on October 1st. Before that time we shall have everything ready at Deptford for supplying current and relieving the Grosvenor station by means of our existing overhead works, because we have been fortunate enough to make arrangements with the local authorities and with the railway company which will enable us to do without incurring any further expenditure. In addition to the large engines that I have mentioned all the smaller engines are practically complete and in working order. The first two large machines which I alluded to are well advanced, the most difficult portion of this operation was to get what is known as the crank shaft of the dynamos, these have been cast in Scotland, and are made of steel, the casting itself was over 75 tons weight, and when finished will weigh over 60 tons, and I think the magnitude of the undertaking will be understood when it is said this is the largest casting that has been made in Scotland. As a wise precaution we ordered three of these shafts, consequently one will be ready in case anything should happen to either of the two, or ready for use in the third machine when it is ordered. The engines for driving these two large dynamos are ready for delivery as soon as we are prepared to receive them. The wharf which runs along the river frontage, 195 feet or thereabouts, is entirely finished, we have a large steam crane on it capable of making a lift of 50 tons in working order; a railway has been made running from the river to the south side of the property, that is the street frontage, we have two cranes running along it each capable of lifting 10 tons, and in the engine rooms we have a travelling crane lifting 25 tons and one of 50 tons. The other important part of the work which has been finished, I think satisfactorily, since we last met, is the main work machinery, that has come to a position and state of perfection which leaves little to be desired, the output of this machine is about half a mile of main per day. I do not know that there is anything more to be said, I think you have reason to be satisfied with your property, and I am sure that anything that can be done by the directors to enhance the value of your property will be done and always has been done.

A vote of thanks to the chairman brought the meeting to a close.

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## The Anglo-American Brush Electric Light Corporation, Limited.

THE directors have issued a report to the shareholders, in which they say they have pleasure in advising the shareholders that the mortgage debentures which were offered for subscription in April last have all been allotted, the applications for the same having been in excess of the amount to be allotted.

As a result of obtaining this additional capital, the directors have been enabled to give effect to the policy indicated in former reports, of extending the capacity of the corporation for carrying on its manufacturing operations; and a provisional contract has been made to acquire the business and properties of the engineering establishment known as the Falcon Works, at Loughborough, in Leicestershire, upon the terms mentioned below.

The directors have also entered into a provisional agreement with the Australasian Electric Light Power and Storage Company for the transfer to the corporation of its business as a going concern. The Australasian Company, which is one of the companies formed in 1881-1882 to work the Brush and Lane-Fox patents, has also acquired by its amalgamation with the Edison Indian and Colonial Company the patent rights of Edison in India, Australasia, and South Africa. The policy of re-acquiring the rights held by the subsidiary companies has already met with the full approval of the shareholders, and the terms of the proposed arrangement, which in the opinion of the directors are fair and equitable to both companies, are mentioned below.

The memorandum of association of the corporation, which was drawn up many years ago, before the present requirements of an electrical manufacturing and contracting company were realised, has been found to be inadequate. It is therefore necessary for this, as well as for a variety of minor reasons, to extend and amend the memorandum of association, and as this can be legally accomplished only by means of a re-constitution of the corporation, the directors have given the whole position their very careful consideration, and now submit for the approval of the shareholders the scheme of reconstruction mentioned below.

The directors take this opportunity of announcing the settlement of the litigation with the Edison-Swan United Electric Light Company in regard to incandescence lamp patents. Under the arrangement come to, the Edison-Swan Company accept a licence to use the Lane-Fox and other incandescence lamp patents held by the corporation, and they pay the corporation a royalty upon the basis of the number of lamps made, but subject to a maximum payment per annum. The corporation, on the other hand, give up the manufacture of incandescence lamps, and agree to buy from the Edison-Swan Company on the most favoured terms to dealers, until the expiry of the Edison patent. The Edison-Swan Company waive all claim to damages, and it will be remembered that in regard to the Cheesbrough patent Mr. Justice Kay was against the corporation, and no appeal was entered, but the corporation agree to pay the Edison-Swan Company's taxed costs. The arrangement, which applies only to the United Kingdom, fully protects the corporation's customers, who will not be subjected to any inconvenience or expense.

The only other litigation in which the corporation is engaged is that relating to compound-winding of dynamos. It will be remembered that in the case against the Orient Steamship Company, which was tried in England in December last, the Brush patent for this process was upheld; on the other hand, the action brought by Messrs. King, Brown & Co., in Scotland, for the reduction of the patent, has been decided in favour of the plaintiffs. This decision is now being appealed against, but the issue will not in any way affect the manufacturing business of the corporation.

With regard to the general business of the corporation, the directors are glad to be able to report very satisfactory progress. It is not practicable to specify in detail the important contracts at present on hand and in view, but it will be interesting to the shareholders to know that the orders booked during the first six months of this year equal in amount the total volume of last year's business, and when it is remembered that the past year showed a very considerable advance upon the business done in previous years, it will be admitted that the present position of the corporation is very satisfactory, and justifies sanguine expectations in regard to the future.

### AMALGAMATION WITH FALCON COMPANY.

The Falcon Company was established in 1883 to take over the works and business of the Hughes Engineering Company. The capital is £60,000 divided into 50,000 preference shares of £1 each and 10,000 ordinary shares of £1 each. The company has, since its formation, carried on successfully the business of building locomotive and other engines, as well as tramway and other cars.

For the four years ending June, 1886, the full dividend of 7 per cent. per annum was paid upon the preference shares, in the following year a dividend of 2 per cent. was paid, and the dividend paid in 1888 on the preference shares was 5 per cent.

The property consists of freehold land covering an area of over seven acres, and several buildings, well adapted to the purposes of iron and brass founding, engine and car making, stores, offices, dwellings, &c., and on the whole the property is well adapted for the corporation's heavy electrical work.

The price to be paid for the whole of the business as a going concern is, £55,000 in fully paid shares of the new company, and £1,000 payable half in shares and half in cash to cover expenses incidental to the liquidation of the Falcon Company.

The directors of the corporation consider the arrangement very advantageous for the following, among other, reasons:—Additional manufacturing works are absolutely necessary for carrying on the business of the corporation. The works of the Falcon Company are suitable for the purposes of the business. The situation of the works is very convenient in respect of economy of manufacture and of conveyance of goods and materials. The purchase price is to be in shares involving no cash expenditure except such as may be necessary for extensions and the amount mentioned above for expenses. The business of the Falcon Company is carried on at a profit, and as it is proposed to continue the same, the capital expended on the purchase will not be unproductive during the period of transition necessary for the adaptation of the works to the new requirements. There will be no loss of time in the acquisition of the property, and this, in view of the urgent demand for a much larger output than the corporation is at present able to deal with, is an advantage of very great importance, and one that could not be as effectually secured by any other available means.

### AMALGAMATION WITH AUSTRALASIAN COMPANY.

The Australasian Company was formed in 1882 to work the Brush and Lane-Fox patents in the Australasian Colonies. The company, as already stated, subsequently amalgamated with the Edison Indian and Colonial Electric Company, and secured the patent rights of Edison in India, Australasia and South Africa. It has also secured the sole agency under the Swan lamp patents and other rights. The company therefore occupies an exceptionally strong position in regard to some of the principal patents which control the more important branches of the electrical industry. Last year the company carried out, by means of apparatus supplied by the corporation, the important contract for lighting the Melbourne Centennial Exhibition, and altogether the company has done important work in organising the business in the colonies, but it has not so far been able to work at a profit, the volume of business having during the past years of depression been but small. The prospects now, however, have materially improved. Under the agreement with the Australasian Company hitherto in force, the corporation has been practically precluded from doing business in Australasia, except through the medium of the Australasian Company, and in the opinion of the boards of both companies, the corporation will, by reason of its manufacturing facilities and greater experience in the field of electrical work be in a better position for developing the business in the colonies than the Australasian Company.

The present capital of the company is £202,386 divided into shares of a variety of classes, but under a scheme of reconstruction which is now before the shareholders of that company, it is proposed to consolidate all classes of shares and to reduce the aggregate capital to £78,065.

The price to be paid by the corporation for the transfer of the business as a going concern is £45,000, payable in fully paid shares of the corporation or of the reconstituted Brush Company as mentioned below, and £1,000 payable half in shares and half in cash to cover the expenses of winding up.

### SCHEME OF RECONSTRUCTION.

It is proposed to transfer all the assets and liabilities of the Anglo-American Brush Electric Light Corporation to a new company to be registered under the title of the Brush Electrical Engineering Company, Limited, with extended memorandum and articles of association.

The present subscribed capital of the corporation is 52,314 shares of £5 each = £261,570. (Of these, 26,803 shares are £5 fully paid up and 25,511 are £5 each with £4 per share called up.)

The capital of the new company is to be £750,000 divided as follows:—£300,000 in 150,000 6 per cent. preference shares of £2 each. £450,000 in 150,000 ordinary shares of £3 each.

The proposal is, that the shareholders of the corporation shall receive in respect of each £5 fully paid share held by them, one preference share of £2 and one ordinary share of £3 in the new company. That the Falcon Company shall receive £55,500 in 11,100 preference shares of £2 each, and 11,100 ordinary shares of £3 each. And that the Australasian Company shall receive £45,500, in 9,100 preference shares of £2 each, and 9,100 ordinary shares of £3 each.

The arrangement will involve the voluntary liquidation of the Anglo-American Brush Electric Light Corporation, and in view of the desirability of removing the distinction at present existing between the partly paid and the fully paid shares by which the market value of the shares is affected, it is proposed that the liquidators should call up the £1 per share remaining unpaid on 25,511 shares.

It will be necessary to obtain the sanction of the debenture holders to the scheme, but as it is proposed to issue debentures of the new company of equal amount to, and on the same terms as, the present issue, the debenture holders will in view of their security being materially increased by the accession of the assets of the Falcon and Australasian Companies, have every reason for acceding to the arrangement.

The share and debenture capital account of the new company will stand thus:—Nominal share capital, £750,000; mortgage debentures, £75,000.

The directors are advised that the sub-division of the capital in the way proposed will tend to appreciably improve its market value, and the numerous precedents for this course afforded by the large railway and other companies strongly support this view.

It is obvious that as a result of this proposed sub-division of the capital, the shareholders will have much greater certainty of receiving satisfactory dividends upon at least a portion of their holdings than if the profits of the business had to be distributed over the whole of the capital alike.

In conclusion, the directors are of opinion that the present is a very favourable opportunity for carrying out a scheme of this nature, which has been under their consideration for some time past, but which, owing to the late unfavourable condition of the industry, and to the want of adequate working capital necessary for effecting the enlargement of the works, has not been practicable before.

After a long period of depression, the business has now entered upon a new and more encouraging phase, and by taking energetic steps to cope with the increasing demand for electrical work of every kind, the company will, it is confidently believed, forthwith place itself in a dividend paying position.

The character and the amount of the work now carried on by the corporation, and the prospects of future business are such that the directors see no reason why the new company should not, from the date of its registration, earn sufficient profits to admit of regular dividends being paid from the outset.

The board are of opinion that the opportunity of the reconstruction should be taken to strengthen the directorate. They propose

### DISTRIBUTION OF CAPITAL.

| | Debentures. | 6 per cent. preference shares. | Ordinary shares. | Total. | |
|---|---|---|---|---|---|
| | | | | Debentures. | Shares. |
| | £ | £ | £ | £ | £ |
| To be issued to debenture holders of Brush Corporation ... ... | 75,000 | ... | ... | 75,000 | |
| To be issued to present shareholders of Brush Corporation... ... | ... | 104,628 | 156,942 | ... | 261,570 |
| To be issued to Falcon Company ... ... ... ... ... | ... | 22,200 | 33,300 | ... | 55,500 |
| To be issued to Australasian Company ... ... ... ... | ... | 18,200 | 27,300 | ... | 45,500 |
| | 75,000 | 145,028 | 217,542 | 75,000 | 362,570 |
| Balance unissued ... ... ... ... ... ... | ... | 154,972 | 232,458 | ... | 387,430 |
| | ... | 300,000 | 450,000 | 75,000 | 750,000 |

to offer seats at the board to one director of the Falcon Company, and one director of the Australasian Company, and they are in consultation with some of the leading shareholders as to the advisability of appointing one or more additional directors.

Also, the directors refer to the notice convening a special meeting of the shareholders and the resolutions set out, and they strongly recommend these resolutions for adoption, in the full conviction that the course suggested will be found to be in every respect beneficial to the shareholders.

## Australasian Electric Light, Power, and Storage Company, Limited.

IN a circular to the shareholders the directors state that they have entered into negotiations with the Anglo-American Brush Electric Light Corporation, with a view to amalgamation with that company. This company, now so well known in the market, has recently decided upon a considerable extension and development of its business, as will be seen by the enclosed circular to its shareholders, announcing the formation of a larger company intended to embrace not only the original company and the Australasian, but also an important engineering works in the Midland Counties well calculated to assist the scheme of development.

The work just carried through, in conjunction with the Anglo-American Company, in connection with the Melbourne Exhibition, and the very marked revival of business, both here and in the colonies, in electrical work have led the directors of the Australasian Company to feel the necessity of obtaining much greater financial strength and manufacturing facilities.

Your directors have, therefore, felt justified, in the interests of all classes of the shareholders, in abandoning the scheme for reduction of capital and the issue of preference shares proposed in the circular of 23rd January last, and have entered into an agreement, subject, of course, to the approval of the shareholders, by which the new Brush Company will take over the entire business of the Australasian Company, including all liabilities and assets, as hereinafter explained.

The consideration to be paid by the new company is a sum of £45,000 in preference and ordinary shares, which will be available for distribution among the shareholders, inasmuch as the Brush Company, in addition thereto, pays expenses of liquidation. As it is not possible to speak with absolute accuracy of the position and liabilities at the present moment in Australia, it has been necessary to provide for the possibility of a reduction of this amount in the event of unforeseen liabilities appearing, or in the event of any of the patents having lapsed; but the directors have taken all practical precautions on these points, and do not anticipate any material modification under this head.

The shares of the Anglo-American Company at present are of the denomination of £5 each, some fully paid and others £4 paid, but the unpaid portion on these latter will now be called up for the purpose of equalisation. These £5 shares are quoted 4¼ ¾, and it is now proposed, in the amalgamation, to make two classes of shares, the present £5 share being represented by one preference share of £2 entitled to 6 per cent., and one ordinary share of £3 entitled to the residue of all the profits.

As in the case of the Anglo-American Company, it will be necessary that the 10s. per share now remaining due upon a certain number of the shares of the Australasian Company should be called up for the purpose of equalisation.

According to the articles of association of the Australasian Company the above sum of £45,000 would be divisible in the following proportions between the original ordinary and the ordinary (Edison) shares, viz.:—The original ordinary £5 shares will be entitled, when fully paid up, to £39,815, equal to about £1 10s. 3d. per share; and the ordinary (Edison) £1 shares (already fully paid), being only entitled to rank for 50 per cent. of their face value in any distribution of assets, will be entitled to £5,185, equal to about 3s. 1d. per £1 share.

The directors anticipate that the shareholders will reap considerable advantage from the much better quotation and freer market which it may be expected the shares of the Brush Electrical Engineering Company will enjoy than is possible, in the circumstances, with the shares of the Australasian Company.

As will be seen by the circular of the Anglo-American Company, the prospects of the trade generally are now brighter than they have ever been, while the addition of the Falcon Engine and Car Works should enable the new company to take quite an exceptional position in regard to the important work now coming to the front in connection with tramways and light railways. The prospects in Australia, according to the advices of the general manager there, are also of the most promising character to any company with resources such as the amalgamated undertaking will possess. The directors, therefore, feel no hesitation in recommending the adoption of the agreement which will be submitted for consideration at a special meeting of the shareholders convened by notice herewith for 23rd inst., at 3.30 o'clock, at the offices of the company. It is hoped that a good number of shareholders will be present at this meeting, but a form of proxy is sent which can be returned to the secretary with any instructions shareholders would like to give with regard to the same, to be filled up and returned before the 20th inst.

It is understood that Lord Thurlow and his colleagues upon the board of the Brush Corporation will continue directors of the new company, and that at least one member of the Australasian board will be invited to join the board of the new company.

## The Edison and Swan United Electric Light Company, Limited.

THE directors in presenting their sixth annual report for the year ending June 30th, 1889, state that the sale of lamps and fittings has progressed in a satisfactory manner during the year, and has resulted in a credit balance of £47,729 5s. 9d.; to this must be added the sum of £25,123 9s. 7d., the balance of account for the year ending June 30th, 1888, making a total of £72,852 15s. 4d., out of which the directors have appropriated the sum of £28,815 14s. 2d. to meet losses realised on finally disposing of sundry installations taken over at the date of the amalgamation, and have, under clause 89 of the articles of association, created a reserve of £4,595 10s. 10d., and they recommend the appropriation for dividend, in accordance with clause 87 of the articles of association, of 7 per cent. upon the amount paid up on the "A" shares, in respect of the year ending June 30th, 1889, and of 3 per cent. further on account of the arrears of preferential dividend on the "A" shares, in respect of the year ending June 30th, 1884.

The supply companies are establishing central stations in London and the provinces, which must lead to a considerable extension of the business of the company.

The appeal of the company from the decision of Mr. Justice Kay was heard before Lords Justices Cotton, Lindley, and Bowen, who reversed Mr. Justice Kay's judgment, and decided that Mr. Edison's patent, November 10th, 1879, was valid.

The Brush Company gave notice of their intention of appealing to the House of Lords, but a settlement has been arrived at by which the case will not be carried to the House of Lords. The Brush Company give up manufacturing incandescent lamps, and they pay the taxed costs of the action.

Viscount Anson, and Mr. Ernest Villiers retire from the board and offer themselves for re-election as directors. Messrs. Welton, Jones & Co. (late Messrs. Quilter, Welton & Co.), the auditors, also retire, and offer themselves for re-election.

## The Exeter Electric Light Company.

IN the first annual report, just issued, it is stated that immediately on the formation of the company numerous obstacles were raised which had greatly retarded the introduction of electric light into the city, but the directors have overcome the difficulties. The directors have since secured (at a very low price) the freehold property in the New North Road, known as the Rockfield Factory, and plant of the highest possible efficiency (acquired on advantageous terms) is now being laid down, which will enable the company to supply the electric light at an unusually low price. The directors are pleased to say that the demand for electric lighting in Exeter has more than realised their expectations. Already a large number of arc lamps and about 1,000 incandescent lamps have been applied for. Contracts have been entered into for lighting several public buildings and places of worship, and some of the most enterprising citizens, including the proprietor of two of the principal hotels (the Half Moon and Clarence) have decided to light their premises with the electric light. To provide the plant required to meet the present demand and the further applications which it is anticipated will be received as soon as the light is being actually supplied, further capital is required. The share capital already subscribed, including shares agreed to be taken, amounts to £7,000.

**The Direct United States Cable Company, Limited.**—At a meeting of the board held on Friday, it was resolved to recommend a final dividend of 3s. 6d. per share, free of income tax, payable on and after the 27th July instant, making, with the interim dividends already paid, 3½ per cent. for the year ending 30th June last, carrying forward a balance of £2,719 2s. 11d. Register of transfers will be closed from the 12th to the 26th July, both days inclusive.

**Anglo-American Telegraph Company, Limited.**—At a meeting of the board of directors on Monday, it was resolved to declare an interim dividend for the quarter ending 30th June, 1889, of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, less income tax, payable on the 1st August to the stockholders registered on the books of the company on the 10th July, 1889.

## TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended 5th July, 1889, amounted to £4,068; and for the week ended 12th July, 1889, amounted to £4,150.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending 12th July, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,793.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 15th July are £2,519, as compared with £2,544 in the corresponding period of 1888. The March receipts, estimated at £7,394, realised £7,370.

# LIGHTNING CONDUCTORS.

By S. ALFRED VARLEY.

(*Continued from page* 10.)

THE writer has already stated he considered Mr. Preece to be in error in maintaining a lightning conductor could be touched with impunity at the time a lightning discharge was passing through; he has also given reasons for believing that Mr. Preece would be very ill-advised if he put into practice what he has publicly stated his willingness to do.

It seems necessary to say a few words on "surging" as bearing more or less on the views put forward by Prof. Lodge, and I quote from the Dr. Mann lectures, as the more recent paper discussed at the Institute of Electrical Engineers is to all intents and purposes a reiteration (in some cases expressed more forcibly) of the views developed in the Dr. Mann lectures.

Under the heading, Experiments on the by path, the following occurs:—"No conductor is able to prevent *side flash however thick* it be made. It may be *a foot* or a *yard* thick and yet *not* stop it. Take a yard of stout brass or copper rod an *inch* thick, arrange it in the path of a Leyden jar discharge, and then arrange as a sort of by path or tapping circuit some very fine wire, such as Wollaston's platinum wire, fig. 1. It may *seem absurd* for any portion of the discharge to *leave* the massive rod and take the hair-like wire *by preference*, especially if an air gap exists at A or B, or at both. Nevertheless a portion *does choose* the fine wire path, and *you get* a little spark at A or B about the sixteenth of an inch long." It is clear from the passage quoted that Prof. Lodge considers self-induction has something to do with the spark seen at A or B, and also that the small spark observed arises from a diversion of a portion of the Leyden jar discharge passing through the brass or copper rod.

FIG. 1.

Fig. 2 represents a conductor with two conducting leads situated near to the extremities of the conductor, and with two leads in the neighbourhood of the centre of the conductor.

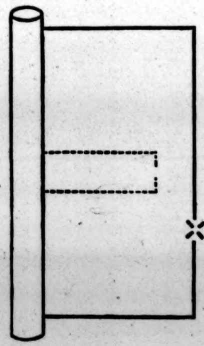

FIG. 2.

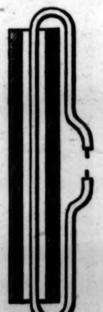

FIG. 3.

Now if the spark observed at the small air space dividing the hair-like wire from the thick brass rod (fig. 1) arose simply from a portion of the Leyden jar discharge leaving the thick conductor, as Prof. Lodge would appear to believe, then if the ends of the central leads (fig. 2) were approached near to one another and a Leyden jar discharge be passed through the conductor, a spark should be observed at the air space separating them. The writer has not actually tried the experiment, but nevertheless he ventures to say no spark would be seen under the above suggested conditions; but if the two ends of the extreme leads were approached near to one another, a spark would then be seen at the air space dividing these leads when a Leyden jar discharge was sent through the conductor.

Now if the spark was caused by a diversion or surging of the discharge from the sides of the conductor, then it should pass as freely through the central leads, as through the leads at the extremities of the conductor. Fig. 3 indicates a tubular conductor, shown in section, with a well insulated wire passing through the centre and over the outside, forming a single convolution. If the two ends of this insulated wire be approached so as to leave a small air space between them, the writer ventures confidently to assert a spark will be observed across the air space at the time a Leyden jar discharge is sent through the tubular conductor; and if the number of convolutions be increased by threading the insulated wire several times through the interior and over the outside, then the spark observed will be a heavier one than that produced by a single convolution; further, if the two ends of the convolutions be connected metallically, so as to form a closed circuit, and leads be taken from the extremities of the tubular conductor, and the ends of these be approached near to one another, the current developed in them at the time of a Leyden jar discharge through the conductor would be so small as to be imperceptible. Now it is evident, if what the writer has asserted be true, that what Prof. Lodge calls "side flash" cannot be due to a surging or diversion of the Leyden jar discharge in this example, for there is no electric connection between the insulated convolutions and the tubular conductor.

The writer, in his article published last year, attempted an explanation of the phenomena attributed by Prof. Lodge to a surging of the Leyden jar discharge, in the following passage:—

FIG. 4.

"I think there is a simple explanation of the phenomenon observed without assuming that any portion of the discharge from the Leyden jar leaves the massive conductor. For discharge to occur, the magnetic inertia of the rod has to be overcome, and directly as the sectional area brought under the influence of the electric current, so will be the amount of magnetism developed in concentric rings at right angles to the rod. When a second conductor is arranged parallel to the thick rod, as shown at fig. 10, a secondary current is developed in this wire at the commencement of the discharge, and another secondary current in the opposite direction to the first one is developed on the cessation of the discharge through the massive rod, and the magnetism developed in the thick rod *is less directly* as the amount of electricity set in motion in the wire Prof. Lodge terms the 'bye-path.'

"The action is precisely the same as that observed by me on a much larger scale, when a lightning discharge struck the suspended wires of the Constantinople and Varna circuit, which I have described in an early portion of this article."

It will be in the memory also of some of the readers of this journal that in giving what was termed a constructive illustration of the inductive system of electrical research a few weeks since, the writer referring to certain observations in connection with the "Alternative Path Experiment," said: "Such result seems to me quite out of harmony with well-established laws, and therefore I suspect what was observed has arisen from causes other than those which seem to satisfy Prof. Lodge."

After the issue of the Journal containing the passage quoted, I received a letter from Mr. Wimshurst, agreeing with what I had said. In this letter (see fig. 4) attention was also called to what I was not previously aware of, viz., that Mr. Wimshurst had shown during the late discussion at the Institute of Electrical Engineers that the B spark of Prof. Lodge's alternative path experiment was in the opposite direction to that of the Leyden jar discharge through the metal conductor, L.

The significance of Mr. Wimshurst's experiment was by no means grasped at the time his letter came to hand; but after the writer's mind had been working unconsciously on it for several days, it broke in upon him as a sort of revelation, and he saw the explanation he had given last year of the by-path experiment (fig. 1) also explained the B spark of Prof. Lodge's alternative path experiment.

Faith in the Franklin-Faraday theory, and a belief in the superiority of the inductive system of research over that of the mathematical method for digging out electrical truths, has led me in the course of both articles to dissent strongly from certain views promulgated and assented to by leading mathematical physicists, and I have been seeking for an explanation of those phenomena observed and recorded by Prof. Lodge which I could not reconcile with what seemed to me well-established laws.

The important observation of Mr. Wimshurst has come to hand most opportunely, and I am naturally pleased to find it supports the views for which I have been contending all along.[*]

Mr. Wimshurst is to be congratulated on having discovered the explanation of the "B spark," and every scientist should be pleased the discovery has been made by one who has devoted so many years to practical research, and who is also one of the most disinterested of electrical workers. At the same time, I cannot help feel a certain amount of regret that Prof. Lodge, the originator of the alternative path experiment, and who has recorded so large a number of painstaking observations in connection with it, should not himself have discovered the B spark was not a diversion or surging of the Leyden jar discharge.

I proceed to say a few words as to the bearing of Mr. Wimshurst's discovery, for facts fairly grasped almost necessarily lead to consequences. Mr. Wimshurst's observation seems to demonstrate in a very striking manner that it is possible to have two electric impulses temporarily moving in opposite directions at one and the same time in a conductor. Faraday's generalisation that there is no hard and fast line between insulation and conduction, has been already referred to in the course of this article. Wherever there is insulation (and the best of conductors insulate) there induction is possible. As far back as 1858 it was pointed out by the writer that in a submarine circuit regarded as a Leyden arrangement, the resistance of the metallic conductor was the only insulation. Mr. Wimshurst's observation goes to show that to sudden discharges of high potential, the magnetic inertia of the molecules of the conductor causes them to act as insulators, through which induction takes place, without immediately breaking them down; and instead of the inertia being overcome by the sudden discharge, the + electricity of the Leyden jars makes room for itself to enter the conductor by driving out the + electricity associated with the matter of the conductor, and the − electricity makes room for itself to enter and meet the + electricity of the Leyden jar discharge by driving out the − electricity, combined with and forming part of the conductor in common with all matter.

2. It emphasises what is already known, that electricity cannot be taken from or added to matter, and it goes to show that when energy is transmitted through a metallic conductor, the quantity of electricity forming the vehicle of such transmission is determined by the mass of conducting matter in the conductor, and this energy is transmitted from molecule to molecule, conduction proper involving a continuous breaking down and reformation of their atomic constitution in succession, the rate at which the molecules are broken down and reconstituted being determined by the potential; in other words, the amount of energy which comes into play.

Prof. Lodge has directed attention to the fact that in the alternative path experiment, the noise made by the discharge is greatest of all, when there exists no alternative metallic path, L, so that discharge occurs through the two air spaces, A and B. He refers also to the fact that the discharge makes the least noise when it occurs through the metallic path, L; and the knobs, B, are so far apart, that no spark occur at the air space dividing the knobs, B; and he mentions that when the B knobs are close enough for spark to occur between them at the time the Leyden jar discharge occurs, although not so heavy as when the path, L, is removed altogether, it is louder than when no spark at B is produced.

I think it has been perhaps overlooked that when the metal path, L, is removed altogether, and the noise of discharge is loudest of all, the statical charge has to be raised to a higher potential to bring about discharge, than when the outsides of the Leyden jars are connected by the conductor, L. Discharge under such conditions is a louder and a heavier one, from two causes; there is, in the first place, a greater accumulation or storage of energy on the surfaces of the Leyden jars, and this greater amount of energy is dissipated in a shorter interval of time, owing to relatively smaller amount of magnetic inertia of the dielectric air which forms the path through which the energy is transmitted.

The observation of Mr. Wimshurst's shows that the side flash experiment is really only another form of the alternative path experiment. I would direct attention to the quotation from my previous article; when suggesting an explanation of the phenomena there observed, I say "the magnetism developed in the thick rod is *less directly* as the amount of electricity set in motion in the wire Prof. Lodge terms the by-path;" what I desire to emphasise is, that the act of the duration of discharge is shorter, and consequently the noise is somewhat greater when a spark occurs at B than when the B knobs are separated so far apart that no spark is produced at the time the Leyden jar discharges through the metal path, L.

I pass on to the bearing of what Mr. Wimshurst has demonstrated on the recorded observations of Prof. Lodge. First, when the outsides of the Leyden jars in the alternative path experiments are connected by the path, L, the potential of the statical charge at the time discharge occurs is practically the same in all cases, for the resistance of the conductors, L, in these experiments may be regarded as almost, but perhaps not quite, a negligible quantity; and therefore the amount of energy dissipated is a definite quantity, and the potential of the induced discharge which occurs at air space, B, can only approach, and never exceed the potential of the statical charge of the Leyden jars; it will be seen that the effect of increasing the sectional area, say of copper conductors forming the path, L, is to increase the magnetic inertia and to reduce the resistance proper; but this latter may here be overlooked, and therefore increasing the sectional area of the conductor, L, would be expected to increase both the quantity and the potential of the electricity developed at the air space, B, but the potential would not be increased so much as the quantity; the spark produced at B would therefore be brighter when conductors of large sectional formed the L path, but the air space through which it was capable of passing would not be so much affected, and this harmonises with what was actually observed.

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[*] I have received a second letter from Mr. Wimshurst, dated July 14th, in which he says: "And in order that you may quite see my view, I may give you a few more words. First, then, I find when the 'by pass' and the balls for the 'B' spark are arranged, the sudden discharge produces a positive side flash from one end of the 'by pass,' and a negative side at its other end, the middle of the 'by pass' gives no side flash. Another feature, so far as I can test it, is *the charge* from the outside coatings passes silently through the 'by pass,' but the magnetic induction (?) of the path produces a B spark in an opposite direction to the first or primary discharge, that is, the charge of the outside coatings is passing in → direction, and the 'B' spark in ← direction. It may, of course, be an oscillation, but clearly it is a very much weaker spark than is due to the primary discharge, and is not in the least a measure of the resistance of the by pass."

It must not be overlooked that the electricity passing at B is by no means a measure of the quantity of electricity accumulated on the surfaces of the Leyden jars; but the amount passing at B increases as the sectional area of the conductor, L, is increased, and the greater the sectional area, the more nearly it approaches to the energy stored up in the Leyden jar; and what I desire to lay the greatest emphasis upon, and which has been referred to more than once both in this and my previous article, is that the duration of the act of the Leyden jar discharge becomes reduced directly as the ratio of the electricity which passes across the air space, B, increases relatively to the energy stored up in the Leyden jars. I think in what has been above said we have an explanation of how it was, varying the sectional areas of the copper wires, L, in the alternative path experiments was observed to affect in a small degree only the length of air space the B spark was capable of passing.

With respect to what was observed in the experiments where iron wires of varying sectional area formed the path, L, and which fairly agreed among themselves, the only suggestion the writer can *now* make is the specifically greater electrical resistance of iron over that of copper. Should such be the explanation, and it is not put forward with confidence, then one would expect that were German silver wire substituted for iron a greater reduction in the length of the B spark would be observed.

I think the true explanation of what was observed in the tinfoil spiral experiments of Prof. Lodge can now be attempted. The writer, perhaps, owes an apology to Prof. Lodge for suggesting that the insulation of the paraffined paper had given way, but, as he said, it was impossible for an electric discharge to pass round a glass tube enclosing a bundle of iron wires without doing work of some kind, and he felt the suggestion of Lord Rayleigh was not sufficient to account for what was observed by Prof. Lodge; the only way he could then see out of the dilemma was to suggest, what practical men too often have experience of, viz., the breaking down of insulation. Mr. Wimshurst's observation affords the explanation—work is done in the tinfoil spiral *itself*, and the result is the B spark.

In the continuation of this article I purpose to show how a link which was wanting, and which has now been supplied by Mr. Wimshurst, confirms my contention as to the basis of the dynamo principle.

The principle which I maintain forms the basis of the mode of action of the dynamo, and for which I have contended ever since I discovered the dynamo principle and constructed the first self-exciting machine in 1866, does not yet seem to have been grasped by our mathematical physicists, and it was characterised not long ago at the Court of Sessions, at Edinburgh, as "simply absurd."

(*To be continued.*)

## THE BIRMINGHAM ELECTRICAL EXHIBITION.

A VERY important event as regards the electrical engineering and allied industries will take place on the 1st proximo, when the Electrical and Industrial Exhibition at Bingley Hall, Birmingham, will be inaugurated by Lady Randolph Churchill. Before stating anything further about this exhibition, it may be as well to say a few words regarding the theories generally held by manufacturers concerning the utility of exhibitions, with special reference to the bearing of such theories upon electrical exhibitions. Let us first see whether the engineers, manufacturers, and others who have displayed their goods at the various exhibitions held during the last 20 years have derived any benefit therefrom. To answer this question we had better see what the manufacturers have to say. On inquiring of different manufacturers in various parts of the country as to what extent they have been benefited by exhibiting their goods at exhibitions, we are almost invariably met by an answer something like this:—"Benefit! Why, none whatever. We found a slight improvement in our business for a certain time after the ——— Exhibition, but since that period there has been a decline, especially from the foreign markets where they are making our goods themselves. This is because we have shown to foreigners for a shilling, inventions which have cost us considerable sums of money to bring out and many hours of serious consideration. We have thus been taught a lesson which we shall not easily forget, and we shall in future be rather reserved in taking part in exhibitions."

It must be confessed that on the face of it there seems a little likelihood of the answer being correct, but on looking more closely into the matter, the reply will be found to be almost entirely at variance with the truth. Years ago before the patent laws were so stringent such a state of affairs might have obtained, but at present it would be almost impossible considering the facilities existing for patenting inventions in different countries, although piracy could of course take place sometimes where patents have not been taken up. As, however, the latter is very rarely the case, the manufacturers' theory may be considered as having no solid foundation, and may therefore be dismissed from the question. The crux of the whole matter lies in the fact that the secret of the invention has been revealed either by workmen employed by the firm, or it has been discovered by those persons who have been permitted to look over the works or factories as the case may be. It has frequently been cases of the first-mentioned order that have been overlooked, and manufacturers have consequently come to wrong conclusions regarding the utility or otherwise of exhibitions. In the second order, however, they may be said to be fully alive to the michief caused by showing strangers over their establishments, even with excellent recommendations from *soi disant* friends.

Turning now to the electrical part of the subject, we find that hitherto only a few electrical exhibitions have been held. That in Paris in 1881 was on a fairly large scale, as was also that at the Crystal Palace in 1882; but since the latter took place no purely electrical exhibition has been held. These were exceedingly well representative of the science of electrical engineering in those days, but since then new apparatus have been brought out, and very great improvements have been made in the construction of all kinds of electrical machinery and accessories, and especially as regards dynamos, alternators, accumulators, lamps, &c. At the Paris Exhibition this year there is a large electrical section, but it is from the Birmingham Exhibition that we expect great things. Almost all, if not the whole, of the electrical firms in the Kingdom will therein participate, and the exhibition will be the largest and the most representative of electrical engineering ever held. Before proceeding further it will, perhaps, not be out of place to mention the proposal for the holding of an electrical exhibition next year in Edinburgh, and we also learn that a similar display will be made at no very distant date in Canada.

Now as far as we have been able to form an opinion from the nature of the exhibits and from the names of the firms who intend making a display at Birmingham, we find that electrical engineers, and those indirectly connected with the trade, have not fallen into the same error as that previously referred to as having been committed by general manufacturers, consequently the theory usually held by the latter does not obtain with electrical engineers, and for very good reasons.

In the first place, only the principals in electrical engineering firms carry on experiments with a view to bringing out something new. These experiments are conducted in such a manner that the workmen cannot possibly become acquainted with the details, and can, therefore, not disclose the secret of the invention, a

**patent for which the firm speedily obtains. This is a great point which many of the manufacturers already referred to do not consider until it is too late. In the second place, electrical engineers also very wisely exclude obtrusive visitors from their works. When these two points are taken into consideration everybody will naturally expect that a very large display of electrical machinery and apparatus will be made. It may here be mentioned that Monday next is the last day for receiving exhibits. The secret of success is generally considered to be due to advertising, and we hope that our electrical firms will in this instance make such an exhibition as will bring more prominently before the notice of the commercial world the advantages to be derived from the use of electric light and power.**

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# THE INHERENT DEFECTS OF LEAD SECONDARY BATTERIES.*

By DR. LOUIS DUNCAN and H. WIEGAND.

SINCE the year 1881, when the inventions of Faure gave such an impetus to the industrial development of lead secondary batteries, their commercial history has been marked by numerous and disastrous failures, while at the same time there has been a steady improvement in their construction and performance until at present they have reached a stage which makes them for some purposes a commercial success. At the same time there remain in the best batteries a number of defects which prevent their taking the place in the practical development of electricity which rightfully belongs to them. The action of the secondary battery is quite well understood. In the Faure type a support plate, usually made of lead or an alloy of lead, has mechanically applied to it some salt of lead (minium or litharge). A number of such plates are placed in dilute sulphuric acid, the alternate plates being connected respectively to the + and − poles of some source of electricity, and a current is sent between them. The result is a reduction on the positive plates (the plates through which the current enters) to Pb. $O_2$, on the negative plate to spongy lead. After this "formation" the action, roughly speaking, consists in a reduction of both peroxide and spongy lead to sulphate of lead on discharge, while on charging they are reduced again to their original composition. We find that in the process of charge and discharge there is a loss of energy varying from 15 to 40 per cent. within the practical limits of discharge rate. If we calculate the theoretical storage capacity of a given weight of lead and peroxide, we shall find that the plates of even the best modern batteries weigh for the same capacity ten times as much as would those of a theoretically perfect cell. We shall find, too, that there is a constant depreciation especially of the peroxide plates, the rate of depreciation increasing with the rate of discharge, and in general depending partly on the way in which the cell is treated, partly on its construction. The principal defects of the modern lead secondary battery are (1) the comparatively small storage capacity, (2) the loss of energy, (3) the depreciation, (4) the low discharge rate necessitated by considerations of efficiency and depreciation.

It was especially the question of the loss of energy in the battery that we wished first to investigate. There are two factors which determine the extent of this loss: In the first place, the number of ampère-hours obtained on the discharge of the cell is less than the number put in; and, in the second place, the P.D. at the terminals is greater during charge than during discharge. This loss of energy exhibits itself in two ways—in a generation of heat and in chemical actions which are not reversed on discharge. It is well known that after a cell has been in use for some time, especially if it be submitted to rapid charge and discharge, there will be found in the bottom of the containing vessel a white, powdery deposit, a sulphate of lead which has been formed from the active material of the plates, and which has not been afterwards reversed. Again, when the cell is charged we find bubbles of gas escaping from the plates during almost the whole of the charge, the escape becoming quite violent towards the last. The escape is at first principally from the positive plate, but afterwards it is from both plates. This escape represents, of course, a loss of energy due to the electrolysis of the dilute acid in the cell, the products being free hydrogen and oxygen.

Let us consider what takes place during the charge and discharge of a cell. Supposing the cell to have been discharged until its P.D. has dropped to 1·8 volts, on beginning to charge, the P.D. increases until it reaches a value of about 2·1 volts—at a normal charge rate—then increases very slowly during a considerable portion of the charge, then increases faster until it reaches a value of from 2·4 to 2·5 volts, when the cell is "boiling." The chemical action results principally in the reduction of the sulphate of lead on the two plates to peroxide and spongy lead respectively. The greater the charge rate the higher will be the P.D., and the sooner will the cell begin to boil and the greater will be the loss.

On discharge, the P.D. drops to from 2 to 1·95 volts for normal discharge rate, where it remains during the greater part of the discharge, there being a gradual fall during the latter part to 1·8 volts, when the discharge should cease. If a high discharge rate be employed, there is a decrease in the capacity and efficiency, and a more rapid depreciation. If the discharge be continued after the P.D. has dropped below 1·8 volts, there will be a formation of white sulphate on the plates, there will be a loss of energy, as will be shown, and there will be a rapid depreciation of the cell. The result of the discharge is a formation of sulphate of lead on both positive and negative plates. If we test the specific gravity of the solution at different times we shall find that the solution has a maximum strength—say 1·200—when fully charged, with a minimum on discharge—say 1·150—the sulphating of the lead decreasing the strength of the solution. The number of ampère-hours obtained on discharge is less than the number put in by an amount depending on the construction of the cell and the conditions of charge and discharge. There is a further apparent loss of energy in the fact that the electromotive force on discharge is less than that during charge.

Our first experiment was made to determine, if possible, whether part of this difference of E.M.F. was not due to the fact that the strength of the solution *in the plugs* varied, it being stronger during charge than during discharge. During discharge, the sulphuric acid in the plugs has its strength decreased by the sulphating of the lead or peroxide. This weakening continues until the diffusion of the stronger acid in the cell produces a condition of equilibrium. It is known that the electromotive force of a cell varies with the strength of the solution, being higher as the strength increases. Gladstone and Tribe have found that when the acid is very weak the chemical action is changed, the result on a positive plate of sheet lead being the formation of streaks of a mixture of yellow and puce-coloured oxides, while on other parts a white substance is formed, which is easily detached, falling in clouds into the liquid. This white substance is probably a basic sulphate of lead. When this action takes place the corrosion of the plate is more than doubled. So if the diffusion in the plug is slow, it may very well happen that there will be a great difference of density during charge and discharge, causing a difference in electromotive force and a formation on discharge of chemical compounds which are not afterwards reduced. A rapid discharge rate would tend to greatly weaken the acid, and therefore to decrease the efficiency and hasten corrosion of the positive plate.

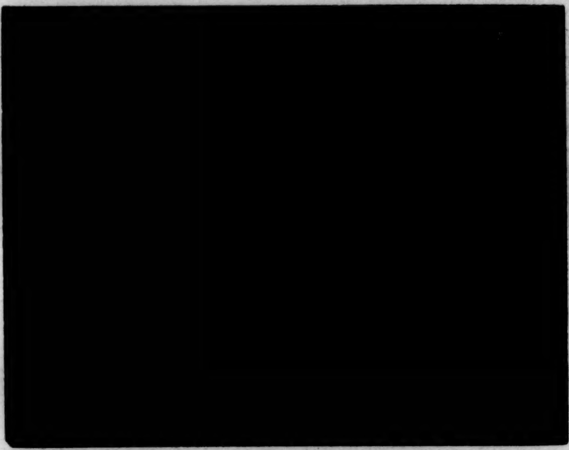

FIG. 1.

To find the rate of diffusion we soaked the plates or single plugs to be experimented on in acid of a specific gravity of 1·175, and then placed them in vessels of distilled water, letting them remain for different intervals of time, and determining the amount of acid diffused out into the water. To give some idea of the magnitude of the result, I select the following figures from a number of experiments. The plates used weighed about a pound and a half (·7 kilos), and were of the grid type:—

POSITIVE PLATE.

| Charged. | | Discharged. |
|---|---|---|
| Time in water. | Acid diffused. | Acid diffused. |
| 1 min. | ·695 grms. | ·29 grms. |
| 5 „ | 1·41 „ | ·60 „ |
| 30 „ | 2·50 „ | 1·43 „ |

NEGATIVE PLATE.

| Charged. | | Discharged. |
|---|---|---|
| Time. | Acid diffused. | Acid diffused. |
| 1 min. | ·86 grms. | ·317 grms. |
| 5 „ | 1·42 „ | ·700 „ |
| 30 „ | 3·05 „ | 1·35 „ |

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* Read before the American Institute of Electrical Engineers, New York, May 22nd, 1889.

The curve shown in fig. 1, gives the diffusion from a charged positive plate.

The total amount of acid in the charged positive plates was (25 grms. of 1·175) about 5 grms.; so it will be seen that the rate of diffusion of the acid in the interior of the plugs is slow, for after 30 minutes, when half of the acid remains in the plug, the rate of diffusion has decreased from about ·7 grammes for the first minute, to about ·025 grammes per minute. While this is hardly the condition of affairs in actual practice where the rate at which the acid is being added or abstracted varies in different parts of the plug, yet it gives us some idea of the magnitude of the quantity. It should be noted that the rate of diffusion is materially the same for positive and negative plates, but that the rate for a discharged is considerably less than that for a charged plate. Keeping these facts in mind, let us pass to the phenomena of charge and discharge.

To investigate the loss of energy from heating, we placed the cell to be experimented on in a wooden box lined with a layer of felt about an inch thick. There was a top for the box, also lined with felt, and through it passed the rod of a stirring paddle and the stem of a thermometer. Experiment showed that the loss of temperature in this arrangement was for a

| Difference between air and box. | Degrees loss per Degree diff. per hour. |
|---|---|
| 7·2° | ·12° |
| 5·1 | ·1 |
| 4·2 | ·95 |

In the experiments we tried as nearly as possible to keep the air and cell at the same temperature, and the correction for radiation could usually be neglected. The cell was charged and discharged under a number of conditions, and the rise of temperature and other data were observed. The losses of energy that occur must, as has been stated, exhibit themselves in heat or in chemical changes which are not reversed. The cell was of the grid type, with four positive and five negative plates. The weights were :—

| | |
|---|---|
| Total weight ... ... ... ... | 25 lbs., 3 oz. |
| Weight of plates ... ... ... | 17 „ 8 „ |
| „ „ vessel ... ... ... | 1 lb., 3 „ |
| „ „ solution ... ... ... | 6 lbs., 8 „ |

This gives a heat capacity for the cell such that the energy lost is approximately 3·2 watt hours per degree.

FIG. 2.

The cell was first charged at 5 ampères until over 150 ampère-hours had been put in; both positive and negative plates were boiling freely. The discharge was at a rate of about 15 ampères. Some of the particulars of the discharge are :—

| Ampère-hours discharge. | Rate of rise of temp. per ampère-hour. | Total rise of temp. | $C^2$ R. |
|---|---|---|---|
| 10 | ·012 | ... | ... |
| 20 | ·01 | ... | ... |
| 30 | ·008 | ... | ... |
| 40 | ·015 | ... | ... |
| 50 | ·03 | ... | ... |
| 60 P.D. falling. | ·05 | 2·03 | 11 watts. |
| 70 | ·12 | ... | ... |
| 77 | ·30 | 3·75 | 13 watts. |

In this case the discharge was carried far beyond the limit of economical discharge. It will be seen that the loss is greater as the discharge continues, increasing slowly until the E.M.F. begins to drop, when it rises very rapidly.

After this discharge the cell was charged at a rate of 10 ampères.

RATE OF RISE.

| Ampère-hours. | Degrees. | Total rise. | $C^2$ R. |
|---|---|---|---|
| 20 | ·04 | ... | ... |
| 40 | ·04 | ... | ... |
| 60 | ·05 | ... | ... |
| 80 | ·08 | 4·7 | 8 |
| 100 | ·166 | 8·9 | ... |
| 120 | ·20 | 11·5 | 12 |

The cell thus charged was discharged at a rate of about 20 ampères. The rate of rise of temperature was very much as in the case of the discharge at 15 ampères. The total rise, with the P.D. down to 1·7 volts, 60 ampères having been taken out, was 1°·1; on further discharge down to ·7 volts, taking about 20 ampère-hours more from the cell, the rise was 4·1°. This again shows that the loss increases as the P.D. falls.

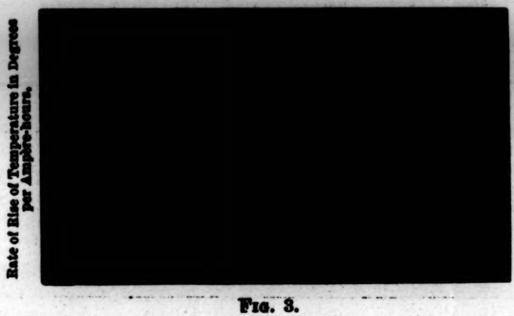

FIG. 3.

The next charge was at 20 ampères. The rate of rise of temperature is given by the curve, fig. 4. The total rise was 30·7°. The rise for 100 ampère-hours was 11·5°. The corresponding values of $c^2$ R were 34 watts and 20 watts.

The effect of a rest is shown on the portion of the curve between 105 and 120 ampères, where a 16-hour rest gives a considerable reduction in the rate of temperature increase. The maximum rate is about ·3° per ampère-hour.

The cell thus charged was discharged at a rate of 30 ampères. The discharge was divided into periods of 20 minutes, with periods of equal length between, the object being to determine, if possible, whether there is a local action in the mass of the plug due to the different chemical conditions of the different parts of the plug, which would especially be the case if the charge or discharge were rapid. As in the previous case of discharge, the rise of temperature was slow, there being a gain of but 1·3° for a discharge of 40 ampère-hours, the heating effect of the current in that time being 12 watts, equivalent to almost 4°. For the first three periods there was little if any rise during the time of repose; for the fourth period there was a rise of about ·1°, or ·3 watt hours. During the fifth period the E.M.F. began to fall, and during repose after it the temperature rose ·15°. The sixth discharge period was with the same current, but at a greatly reduced P.D. and resistance. It lasted 12 minutes; after it the temperature rose ·5°, corresponding to 1·5 watt hours. The output of this discharge was 44 ampère hours at a normal P.D.; 11 at a low P.D. The total rise of temperature was 3·5°; the value of $c^2$ R was 16 watts.

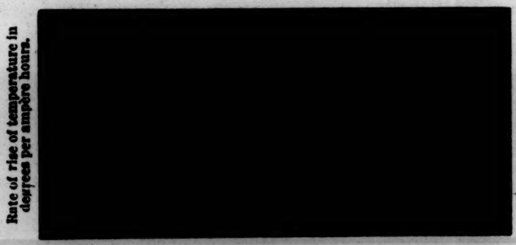

FIG. 4.

The cell was then charged with 70 ampère-hours at 30 ampères, the same periods of repose being allowed. There was a definite rise amounting on the average to about ·2°; after the first period the rise was but ·1°, the others slightly over ·2. The details of the charge were :—

| Ampère-hours. | Rise in temp. | Rate. | $C^2$ R. |
|---|---|---|---|
| 15 | 1· | ·067 | 4·5 |
| 40 | 4·4 | ·18 | 11·5 |
| 70 | 13·1 | ·29 | 20·5 |

The details of the discharge at 30 were :—

| Ampère-hours. | Rise. | Rate. | $C^2$ R. |
|---|---|---|---|
| 10 | ·14 | ·014 | 3·2 |
| 25 | ·63 | ·032 | 7·7 |
| 35 | 1·02 | ·04 | 10·7 |
| 45 | 1·62 | ·06 | 13·7 |
| 54 P.P. fell. | 2·62 | 1·1 | 16·5 |

The rise during the periods of rest for this discharge was at first small, but afterwards something over ·2°.

The next charge was at a rate of 40 ampères. The following are the figures :—

| Ampère-hours. | Rise of Temp. | Rate. | $C^2$ R. |
|---|---|---|---|
| 20 | 1·5 | ·075 | 8· |
| 43 | 3·9 | ·11 | 15· |
| 63 | 8·0 | ·20 | 22· |
| 80 | 13·2 | ·3 | 28· |
| 97 | 18·65 | ·32 | 34· |
| | rest | | |
| 106 | 21·35 | ·30 | 36·75 |

The rise during periods of repose was ·1° for the first period, ·7° for the second, and decreased as the charge increased until it reached a value of about ·2°.

The discharge corresponding to this charge was also at 40 ampères, and was divided into periods as before.

| Ampère-hours. | Temp. | Rate. | $C^2$ R. |
|---|---|---|---|
| 14 | ·46 | ·033 | 5· |
| 28 | 1·16 | ·05 | 11· |
| 42 | 2·24 | ·077 | 17· |

Whether the rise in temperature during the periods of rest is due to the heat of the plates being diffused into the liquid, or is due to a local action in the plugs is difficult to determine. If it were due to local action we would expect a greater rise during the first periods of the charging experiments, and this is what we find. If it were due simply to diffusion of heat, we should have approximately the same effect at corresponding periods of charge and discharge, the rates being the same, but we see that it is greater during some of the charge than during corresponding discharge periods, and it is not uniform even during charge and discharge, it being sometimes greater when the resistance of the cell is less. Some of the rise is undoubtedly due to the diffusion of heat from the plates, but it seems certain that a part of the effect is due to the local action.

Our next experiments were with negative and positive plates which were in different conditions of charge and discharge. At first a cell was made up of fully charged negative plates, with positives from which 45 ampère-hours had been taken, and it was discharged in the calorimeter at 10 ampères.

| Ampère-hours. | Rise. | Rate. | $C^2$ R. |
|---|---|---|---|
| 4·2 | ·05° | ·012° | ·5 |
| 17·5 | ·20 | ·011 | 1·8 |
| Rest. | | | |
| 35·8 | ·45 | ·009 | 2·6 |
| 49·1 | ·85 | ·03 | 4·0 |
| 66·1 P.D. fell. | 3·05 | ·13 | 6·0 |

Next a cell with fully charged positives and negatives from which 47·5 ampère-hours had been taken, was discharged at a rate of 5 ampères.

| Ampère-hours. | Rise. | Rate. | $C^2$ R. |
|---|---|---|---|
| 10· | −·1° | −·01° | ·5 |
| 15·5 | −·15 | −·01 | ·75 |
| 20·5 | −·20 | −·01 | 1·00 |
| 23· | −·20 | ·00 | 1·1 |
| 29· | −·20 | ·00 | 1·4 |
| 34· | −·20 | | 1·65 |
| 39· | −·17 | +·008 | 1·9 |
| 41·5 | +·05 | +·08 | 2·05 |
| Rest. | | | |
| 47·5 | +·28 | +·04 | 2·45 |
| 49·5 P.D. fell. | +·50 | +·11 | 2·55 |

Cell short-circuited
for very small current.

| | |
|---|---|
| 1 hour. | + ·80 |
| 6 hours. | + 3·00 |
| 11 hours. | + 5·2 |
| 22 hours. | + 11·2 |
| 23 hour. | + 11·8 |

After this exhaustive discharge the cell was charged at 5 ampères, attempts at discharge being made at intervals. At first the P.D. fell at once on closing the discharge circuit, but after about 16 ampère-hours had been put in a discharge of 5 ampères for eight minutes was obtained. The temperature, which had been rising quite fast, began to rise slowly at this point, the rates being given by the curve.

The cell boiled with a charge of 117 ampère-hours, when the total rise of temperature was 96°, $c^2$ R = 7 watts. For a charge of 160 ampère-hours the rise was 17·3° with $c^2$ R = 9 watts.

Another discharge of a negative cell which had 58 ampère-hours taken out gave :—

| Ampère-hours. | Rise. | Rate. | $C^2$ R. |
|---|---|---|---|
| 9 | 0° | 0° | 5 |
| 22·2 | ·39 | ·019 | 2·0 |
| 31·0 P.D. fell | ·61 | ·026 | 2·5 |
| 34·2 | ·90 | ·09 | 2·7 |

This gave the total capacity of the negative plates at a discharge rate of 5 ampères as about 90 ampère-hours; the previous experiment gave 93. The capacity of the positive plates was 94 ampère-hours. It was noticed in these experiments that when a partly run-down negative was used, the fall of potential after a value of 1·5 volts was reached, was very rapid. From 1·3 to ·5 volts took less than a minute, while in another minute the value had reached ·25 volts, and it was soon only a few hundredths of a volt. With the discharged positive, on the contrary, the fall was slow. After a value of 1·35 was reached, the fall in a half-hour was only to 1·04 volts. and in four hours it was ·66 volts. After several hours short circuit, when the value had reached a few hundredths, the circuit was broken. In five hours the value was 1·65, and the next day it was 2·02 volts. With some plates made by depositing thin layers of spongy lead and peroxide on lead support plates, the effect was still more marked. Here the P.D. of a negative plate fell from a value of 1·8 to ·05 in 10 seconds; while with the positive the fall was gradual.

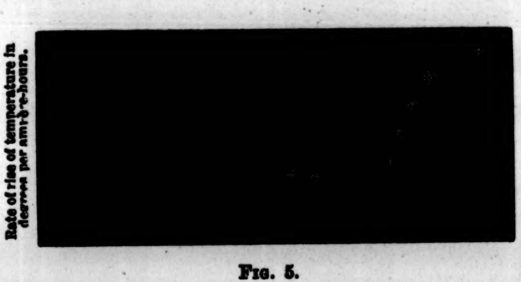

FIG. 5.

Now let us see what our experiments, as far as we have carried them out, show. In the first place the loss that exhibits itself in heating increases as the charge or discharge goes on, not being very great in the latter operation until the P.D. has begun to fall. The loss is greater during charge than during discharge. For instance, take a discharge at 15 ampères, the P.D. begins to fall when 60 ampère-hours have been taken out. The total rise in temperature is 2·03°, while the rise due to the heating of the current alone ($c^2$ R) should be 3·4°. In other words, there has been an absolute lowering of the temperature by all the other actions outside of the Joule effect. Taking a charge at 10 ampères, the rise for a charge of 100 ampère-hours was 8·9°, with a loss due to the Joule effect corresponding to 3°, a difference of 5·9°. The difference in the losses for charge and discharge—neglecting $c^2$ R—is about 5·3°. For a charge of 120 ampère-hours the rise was 11·15°.

We will find the same results in all of the other records, there being sometimes an absolute fall of temperature on discharge. This is without doubt due to the fact that the acid is strengthened on charge, weakened on discharge. In changing from a specific gravity of 1·14 to 1·18, the evolution of heat is such as to raise the temperature of the solution about 3·2°; there will be a corresponding cooling effect on discharge.

To the above charge at 10 ampères there was a discharge at 20 ampères, which gave a total of 84 ampère-hours, of which 60 were at normal P.D.; the rise for normal P.D. was 2°; the total rise was 4·7°. $c^2$ R = 12·1 watt-hours for the 60 ampère-hours at normal P.D., corresponding to 3·8°; the total value of $c^2$ R for the 84 ampère-hours was 15·1, corresponding to 4·7°. The total heat loss in the process of charge and discharge was 11·5 + 4·7 = 16·2°, or about 51 watts. The total loss, obtained from taking the difference between charge and discharge energies, calculated from the ampère-hours and potential difference, was 98 watts, more than half of which appeared as heat. Of the 51 watts which appeared as heat, 27 were due to the Joule effect, 34 to other causes. We believe that part of this loss—a very small part—is due to local action between the positive material and the support plate. Another part is due to local currents in the plugs themselves. When the plate is charging or discharging, the distribution of current in the plug is not uniform, but it is denser at the surface than in the interior. After a while the plug is not uniform in its chemical composition, and there are doubtless eddy currents in such a way as to tend to bring the plug to uniformity of chemical condition. These will be more important as the current rate increases. The last part af the charge of the cell consists largely in the electrolysis of the dilute acid with a liberation of oxygen and hydrogen. It is known that heat is generated in this process, the amount depending on the density of the acid and the nature of the electrodes. M. Gramme in some experiments on the electrolysis of water, only utilised 50 per cent. of the energy expended in producing electrolysis, the remainder being lost. In our own case, when the charge has reached such a point that the reduction of the plates is complete, and the principal action is the electrolysis of the solution into free hydrogen and oxygen; if the total P.D. is 2·5 volts, and if the energy of combination of oxygen and hydrogen corresponds to about 1·5 volts, we may expect of the energy of 2·5 watt hours, corresponding to a charge of 1 ampère-hour, 1 watt hour to appear as heat. If we look at the tables, we will see that the rate of rise of temperature for overcharge is in the neighbourhood of ·3° per hour per ampère, and this corresponds to about 1 watt, as we would expect. As this action (shown by the evolution of gas from the plates) continues through the whole of charge and part of the discharge (doubtless due to local action in the latter case); we will always have *some* corresponding rise of temperature, although it will not reach its full value until the cell is boiling.

The rise of temperature then, is due to:—

(1) The Joule effect, 27 out of 51 in this case.

(2) Currents caused by local action between active material and support.

(3) Currents caused by local action in plugs.

(4) Heat losses corresponding to electrolysis of solution into free oxygen and hydrogen.

The last three probably account for the remaining 3½ watts.

But there are 47 watts left unaccounted for, which must be due to chemical changes not reversed. The most important of these, *as far as loss of energy is concerned*, is doubtless the formation of free hydrogen and oxygen. Another component of the 47 watts is due to the local action between the plugs and support. But we believe the most important, as far as *deterioration* is concerned, is in the formation of irreversible compounds caused by the weakening of the acid in the plugs. We have found that the rate of diffusion in the plug is comparatively slow, so that during a rapid discharge there must be weak acid in the plug. Where the outer layer of active material is reduced, the inner layer is surrounded by weak acid, causing a lowering of the E.M.F. and corrosion, as described by Gladstone and Tribe, with a considerable local action between the outer and inner layers. As the rate of diffusion is less with a partly discharged than with a charged plate, a heavy discharge rate has a more marked effect with a partly discharged than with a fresh cell, as experience has shown.

These are, we believe, the principal sources of loss in a lead secondary battery, and the depreciation can be mainly charged to them. The expansion and contraction of the plugs in a grid plate is another source of trouble, and cannot be avoided. Our own experience has been that the losses are less with plane plates, coated with thin layers of active material, than with plates made of the grid form. Under any circumstances, an increase of surface for a given current rate is to be desired, as it lengthens the time of charge before the violent boiling occurs. A plane plate gives a uniform distribution of current, and, therefore, very little local action.

## LEGAL.

**Foljambe v. the Duke of Marlborough.**—This was a motion which came before Mr. Justice STERLING. The plaintiff, who is the owner and occupier of No. 2, Carlton House Terrace, sought to restrain the Duke of Marlborough, who resides at No. 3, the adjoining house, from using in the basement of that house a steam engine so as to cause a nuisance or danger to the plaintiff's premises by way of noise, vibration, or heat. The engine complained of was used by the defendant for the purpose of generating electricity to light his house. The plaintiff alleged that while the engine was working the noise and vibration experienced by the occupants of his house constituted a very serious nuisance, and that the heat from the furnace, which passed through a flue in the wall of the plaintiff's house, was so great as to cause cracks in the wall and to give rise to imminent risk of setting the house on fire. It was stated on behalf of the duke that he proposed to connect the furnace with another flue, and to take measures which he was advised would reduce the heat, vibration, and noise so as to do away with the nuisance complained of, and he offered to give an undertaking in terms of the notice of motion, with this exception, viz., that on Thursday, the 18th, he should be allowed to burn the furnace for six hours and to run the engine for two hours between 10 and 4 for the purpose of ascertaining by way of experiment whether the engine could be used so as not to cause any nuisance to the plaintiff. This proposal being agreed to by counsel for the plaintiff, the motion was directed to stand over for a fortnight upon the above undertaking.

Mr. Graham Hastings, Q.C., and Mr. W. C. Druce were for the plaintiff; and Mr. Buckley, Q.C., and Mr. Chadwyck-Healey for the defendant.

## THE ELECTRIC LIGHT AT ROME.

[FROM OUR CORRESPONDENT.]

THE authorities of Rome have come to an agreement with the local gas company (Societá Anglo-Romana per l'Illuminazione di Roma col gas ed altri sistemi). This company has for several years, in addition to its gas works at Oerchi, carried on an electric establishment capable of furnishing 2,700 effective horse-power. In virtue of this agreement the company has obtained the right of fitting up another electric works at Tivoli, and of distributing electric currents in certain out-lying districts of the city for lighting and other purposes.

By means of the new works the enormous water-power existing at Tivoli is to be utilised for the production of an electric current. To this end about 1,700 horse-power is to be actuated by turbines to be erected on the spot. The current thus produced at Tivoli is to be conveyed by overhead leads to Rome, a distance of about 30 kilometres (about 18½ miles). At Rome the leads will join the under-ground cables in the city.

The installation will be so arranged that the current coming from Tivoli can be used conjointly with that produced in the electrical works. In other words, the Tivoli works form a supplement to those at Oerchi, so that the Roman Gas Company has at its disposal a total of 4,400 horse-power.

We may assume that the Tivoli electrical works, which are established on the Zipernowski-Déri-Bláthy system with alternating current transformers, will be surpassed in magnitude by no other electric works. It is the first utilisation, on the large scale, of remote water-power for lighting a city.

The entire execution of this project, both mechanically and electrically, is entrusted to the firm Ganz and Co., of Buda-Pest.

## CORRESPONDENCE.

### Spinning Crystal.

Assuredly there is no new thing under the sun! I have to thank "F. M." for drawing my attention to the article in the *Magazine of Science* on this subject. As, however, magazine articles are not always so trustworthy as original papers, I have looked up the titles of all the papers published by M. Gaudin and have read those which bear on this subject. The two papers in which his experiments are described are in the *Comptes Rendus*, 1839, vol. viii., p. 711; and 1841, vol. xii., p. 947. As I have so far ignored M. Gaudin's work, simply because I did not know of it, and it would appear that it is not well remembered, for though more than two years have elapsed since I first gave an account of my experiments, "F. M.'s" letter is the first intimation that I have had of it, I should be glad now if you can find space to give an abstract of these two papers.

#### *Abstract of the First Paper.*

"Quartz that has been melted, placed between crossed tourmalines, does not possess any power of producing coloured rings. There is perfect darkness.

"Pieces of rock crystal heated in a platinum tube and dropped into water fly all to pieces, but if a drop of melted crystal is allowed to fall into water then, though there is a great commotion, it does not break, but remains clear. These drops make excellent lenses. They become by this hardening process so altered that they may be hammered on a brick, but the hammer rebounds, only producing splinters, or, in the case of a very violent blow, sparks are freely produced. These tempered or hardened heads of silica resemble steel in elasticity and tenacity, and if it would not be possible to make torsion threads, or springs of precision, with this material, at least blowpipe pliers and all sorts of common things could easily be produced.

"As it would be important to examine the sounds produced by threads of melted quartz and their electric property, which appears very energetic, I send 15 to 20 of different sizes, and three to four feet long.

"Compounds of silica behave in much the same way. Paving stone can be drawn into threads which are white, pearly, silky, and iridescent. They might even be mistaken for silk, and globules formed by melting the stone are exactly like pearls, but harder.

"I have no doubt now that the permanent viscosity of silica is due to the vaporisation which so evidently colours the blowpipe flame yellow, just as lime or magnesia give an orange, or oxide of chromium a purple colour.

"Emerald can be drawn into threads which are stronger than the threads made from quartz."

### *Abstract of the Second Paper.*

"It was while repeating my experiments on artificial rubies at the Ecole des Mines, before the Commission appointed by the Academy, that I began to have any idea of the perfect viscosity of silica. I placed in the lampblack crucible a fragment of silica, and directed upon it an oxyhydrogen flame, which caused it as soon as it was softened to bend about like a viscous body. After some trouble I was able to draw it out as easily as glass, but it was necessary to employ very small quantities and to make use of a very rapid movement.

"Melted silica is the most ductile substance in existence. It never crystallises or cracks. The threads are stronger and more flexible than glass threads of the same size, but the greater flexibility seems to be due to the greater effect of tempering.

"The volatility is so great that it is impossible to make globules more than 3 millimetres in diameter. I have made threads as fine as spider web, which show iridescence in the same way, and which can be twisted and tied like cotton.

"Silica threads are clear like glass. Sandstone threads are pearly white, and are so brilliant that satin looks dull by the side of them.

"Alumina cannot be drawn into threads, but amianthus, garnet, and emerald are ductile. The melted emerald is like opal.

"Globules of silica make lenses which are perfectly transparent and very nearly achromatic, because of the small dispersive power of the material."

It will be seen from these that M. Gaudin has certainly anticipated me in making threads of silica, but those who are acquainted with my work, of which I gave an outline at the Royal Institution on June 14th,[*] will recognise that something more remained to be done before it would be possible for your correspondent "F. M." to say that "quartz threads are likely to play a considerable part in the future of our galvanometers, &c."

My experience agrees almost entirely with that of M. Gaudin. I do not think that his explanation that the flexibility of threads is due to tempering is correct. As I showed in the Cantor lectures at the Society of Arts last spring, the tenacity of fine fibres is almost independent of the way in which they are produced. A thick fibre has a far less tenacity than a thin one; nevertheless, a thick fibre dissolved away by hydrofluoric acid gradually increases in tenacity as it gets finer, and has at any time practically the same strength as an equally fine fibre shot straight from the bow. I had before making these experiments concluded that the tenacity of the finer fibres was due to their more sudden cooling, but these observations increase the probability that there is something analogous to surface tension in the solid fibre.

I have never noticed the volatility which has been so apparent to M. Gaudin and which he so often refers to. Though I would not assert that he was mistaken, I cannot help thinking that some doubt is thrown upon his views by the fact that the tapering ends of fibres drawn off in the oxyhydrogen jet are ultra microscopic, or that quartz held in the electric arc swells up and produces perfect bubbles. Something is, no doubt, escaping; but if it is silica, and the bubbles also are silica, how is it that they can exist at all? However, I would rather not discuss this point further until I have made experiments, with M. Gaudin's observations to guide me.

**C. V. Boys.**

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### Electric Lighting in Paris.

Will you allow us to call your attention to an error in your issue of June 5th, regarding Thomson-Houston apparatus. The communication entitled "The present position of the electric light in Paris," describes the lighting done by the Popp Company, and referring to the Thomson-Houston arc dynamo, says that it is giving a current of 30 ampères and is excited with a Gramme dynamo.

The current is only 10 ampères, and the dynamo is our ordinary MD 50-light series-wound machine, and has no separate exciting arrangement. This same error appeared in the first description of the plant in the *Bulletin Internationale de Electricité*, and now that it it has reappeared in your paper we hasten to correct the mistake.

**Thomson-Houston International Electric Co.**
*For the* ATTORNEY JAS. F. MEECH,
*Ppa.* LOUIS J. MAGEE.

Hamburg, *July 9th*, 1889.

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### A Misapprehension.

I see in the REVIEW that the City of Liverpool is advertising for an electric inspector. He must be "a well trained electrical engineer." He "will not be allowed to engage in private practice, and will be required to devote his whole time to the duties of his office." "Age not to exceed 30." In short, he is to be a highly trained man at his very best, entirely dependent on his salary (not 30s. a week), and at a month's notice may be left a beggar, "on the last day of any calendar month." What sort of well-trained electrical engineer does the City of Liverpool expect to get on such terms?

**Surprised.**

[Our correspondent has evidently misread the advertisement. The salary is £160 per annum.—EDS. ELEC. REV.].

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### The Magnetic Properties of Alloys.

I have recently been making some experiments on the magnetic properties of an alloy of iron and nickel. A statement of the result may be of interest to some of your readers. I am informed by Mr. Riley, of the Steel Company of Scotland, who gave me the sample I have used, that it contains 24·5 per cent. of nickel and 0·85 per cent. of manganese. It proves to be almost non-magnetic, its permeability being only 1·4, much the same as that of manganese steel. On heating a block of the metal to a high temperature and allowing it to cool, and noting the temperatures at successive times, it is found that the curve expressing the relation between temperature and time exhibits no disturbance such as I have observed with wrought iron and steel. The non-magnetic properties of this material are very remarkable, both iron and nickel being strongly magnetic.

**J. Hopkinson.**

*July 15th*, 1889.

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[*] *Nature*, July 11th, 1889.

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